1995-03

An analysis of the acquisition and management of automatic test equipment in organic Army depots

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THESIS

AN ANALYSIS OF THE ACQUISITION AND MANAGEMENT OF AUTOMATIC TEST EQUIPMENT IN ORGANIC ARMY DEPOTS

by

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March , 1995

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE 1995, March	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE AN ANALYSIS OF THE ACQUISITION AND MANAGEMENT OF AUTOMATIC TEST EQUIPMENT IN ORGANIC ARMY DEPOTS

5. FUNDING NUMBERS

6. AUTHOR(S) Urban, Dennis W.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

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14. SUBJECT TERMS Automatic Test Equipment (ATE), Army Depots, Competition, Depot Maintenance, Diagnostics, Testing, BRAC

15. NUMBER OF PAGES 92

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

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AN ANALYSIS OF THE ACQUISITION AND MANAGEMENT OF AUTOMATIC TEST EQUIPMENT IN ORGANIC ARMY DEPOTS

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1995

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ABSTRACT

The purpose of this thesis is to analyze the effectiveness of management practices, policies and regulations that affect acquisition of Automatic Test Equipment for depot level testing of weapon systems in organic Army depots. The main focus is not to determine whether the policies and regulations are being obeyed, but rather to determine whether in actual practice the most cost effective solutions are being implemented. This requires a close look at the organizations involved, along with their management goals and strategies. The results of this thesis will be documented in the form of lessons learned so that managers involved in depot level ATE selection can read and benefit from past experiences.

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I. INTRODUCTION

Department of Defense (DoD) procures automatic test equipment (ATE) in support of diagnostic testing and additionally in support of factory acceptance testing. A recent Institute for Defense Analysis (IDA) study estimates that the overall DoD expenditures on Automatic Test Systems (ATS) over the period 1980 through 2000 is likely to exceed $100 billion. Historically, DoD ATE acquisition and management activities have not been well coordinated across all services. Applied investment strategies have principally focused on individual system requirements, often at the expense of shared development resources, production economies of scale, and lost opportunities for common mission and logistics support use. These practices have drawn the attention of many agencies interested in reducing DoD's costs of doing business. [Ref. 1]

ATE acquisitions represent a significant cost to DoD. If anything could be done to improve this situation, it would reduce the overall cost to the taxpayer, or, at the very least, free up money that could be put to better uses within DoD. For these reasons, Congress, Department of Defense (DoD) and Department of Army (DA) have expressed interest in further analyzing the management of ATE within the Government owned Army depots. These Army-owned depots are called "organic" depots and are in contrast to those that are contractor owned and operated.

Many studies suggest that depots are utilizing a sub-optimal mix of ATE in their shops. Much of the existing depot ATE is one-of-a-kind, difficult to maintain, expensive and special purpose developmental ATE. Depots have also been procuring numerous items of commercial off-the-shelf (COTS) ATE. In contrast to COTS and special purpose ATE, Army policy requires use of Army developed, general purpose, standard ATE. Nonetheless, waivers to Army policy have been routinely

granted. These ATE acquisitions have come under the scrutiny of General Accounting Office, DoD, and DA in the form of audits and studies.

Depots suggest that the problem lies with Program Managers (PMs) who lock in suboptimal special purpose ATE early in the weapon systems' life cycles without proper regard to its impending impact on depot costs once the weapons reach the Operation and Support phase.

PMs, on the other hand, observe that depots, when given the choice, frequently utilize suboptimal ATE in support of new weapon systems by gravitating toward ATE solutions that consist of old existing familiar ATE or a proliferation of new COTS ATE.

The United States Army Test, Measurement, and Diagnostic Activity (USATA), the organization that sets and enforces policies for Army ATE investments, observes that both depots and PMs appear to have parochial interests that often result in acquisitions of ATE that are different than the standard ATE required by Army policy.

Although all three organizations mentioned above have responsibilities for depot testing, their interests may be piqued by different concerns and goals. This thesis will be investigative in nature and address what has happened, why and whether it is an effective way to meet testing needs of organic Army depots.

This chapter defines the unique elements of the overall ATE issues being addressed along with the limitations of the scope of this thesis.

A. THESIS OBJECTIVE

The purpose of this research project is to analyze the effectiveness of management practices, policies and regulations that affect acquisition of Automatic Test Equipment (ATE) for depot-level testing of weapon systems in

organic Army depots. Other services' management policies and regulations will be summarized but without any in-depth analysis of their effectiveness.

The main focus of this analysis is not to determine whether the policies and regulations are being obeyed, but rather to determine whether in actual practice the most cost-effective ATE solutions are being implemented. This will require a close look at the organizations involved, along with their management goals. Results of this study will be documented in the form of lessons learned so that managers involved in depot-level ATE selection can read and benefit from past actions.

B. THESIS OUTLINE

Chapter II. Background. This chapter will provide the basic insight into the nature of depot-level testing and its relative place in the logistics chain. Other services' ATE policies and regulations will be briefly summarized. ATE Life Cycle costs will be discussed in order to identify the major cost drivers that influence this study.

Chapter III. Organizations and Missions. This chapter will describe the roles and responsibilities of Army organizations involved with acquisition of depot ATE.

Chapter IV. Analysis. This chapter will analyze the goals and strategies of the organizations involved with depot ATE selection. It will analyze their strategies and actions in the context of their goals. Finally, it will explain why these organizations often have conflicting strategies for depot ATE.

Chapter V. Conclusions, Recommendations, Summary. This chapter will summarize the research findings and make recommendations that will be aimed at improving the current ATE selection process.

C. THESIS SCOPE

1. Diagnostic versus Functional Testing

In factories, where weapon systems are being manufactured, the items need to be tested as they come off the production line to ascertain that they work properly. This type of testing is performed to determine that items are "functioning" and thus is called functional testing. Depots, to a limited extent, also perform functional tests. They do so to determine that overhauled or repaired items work properly.

When a weapon system fails, that failure is dealt with in a manner consistent with the weapon system maintenance concept and the logistics support structure. Ultimately, it is necessary to isolate the fault to a part or group of parts so that they can be replaced or repaired in order for the weapon to once again become fully operational. Regardless of the level of maintenance, this is called diagnostic testing.

Whereas both factories and depots routinely perform functional tests, it is depots that routinely perform diagnostic tests. In the factory, if a production item fails the functional test, it is common for the design or manufacturing engineers, who are very familiar with the weapon system, to troubleshoot the failure by utilizing the functional testers to perform limited diagnostics. The reason this works is because of the wealth of knowledge and skills these people possess. It would seldom be cost-effective to employ these high cost personnel on a routine basis to perform the troubleshooting that is done in the depots with a lower skill base. Although this thesis studies all depot testing, most of the focus is on diagnostic testing because this is where the depots' mission is most unique.

2. Manual versus Automated Testing

Whereas diagnostic tests are performed for purposes quite different than functional tests, each can be either manual or automated. In the Army, all test equipment is called Test, Measurement and Diagnostic Equipment (TMDE), whether manual or automated. Automated TMDE (ATE), is much more costly and difficult to manage than manual TMDE. For these reasons, ATE is a focus of interest for many organizations and hence is the focus of this thesis.

3. What Level of Maintenance

Diagnostic testing can be done at any or all levels of maintenance and can be performed by soldiers, Government civilians or contractor personnel. It can be done in the field, at Government facilities or at contractor facilities, and can be either automated or manual. This thesis will be limited to automated testing of weapon systems in organic Army depots.

4. Test Program Sets

ATE is, by definition, the actual test equipment hardware. However, the ATE hardware requires additional components in order to be able to perform weapon system diagnostics. It is necessary to have a Test Program Set (TPS) in conjunction with the ATE in order to perform the testing function, much like it is necessary to have application software in a home or office personal computer to perform the specific functions we desire.

The TPS contains three items:

a. Software

This is the code that is written to control the ATE by making it provide power, send appropriately timed stimuli, take measurements, and analyze those measurements for each unit under test (UUT). It is analogous to application software written for personal computers.

b. Hardware

These are the Interconnect Devices (ICD) that are used to connect the ATE to each weapon system's UUTs. Each ICD contains the wiring and circuitry that plugs into the ATE on one end and into the weapon system or components on the other. Some ICDs contain extensive circuitry and are quite complex and expensive.

c. Documentation

This includes the written instructions, regardless of media (software, microfiche or hardcopy) that provide the necessary instructions to operate the weapon system TPS in conjunction with the ATE for which it is written.

TPS costs for a weapon system often exceed ATE costs and vary greatly among different models of ATE. The following is but one example of why.

TPSs that are designed to perform what are called "go-no-go" tests are considered functional TPSs and serve to determine if the UUT is good or bad. On the other hand, diagnostic TPSs perform operations to fault-isolate to the failed component. Although depots need to perform both types of tests, at all other levels of maintenance functional testing is more common. Testing in the field is usually done to determine which Printed Circuit Board (PCB) or black box to replace, rather than to fix the PCBs or black boxes themselves.

The Army standard ATE, IFTE, is a primarily a functional tester, but it contains some diagnostic capabilities. As such, it mostly connects to inputs and outputs of the entire UUT and exercises those inputs and outputs to ascertain that the UUT performs as it should. If the UUT fails, this functional tester is usually not able to determine which component failed without prompting the operator to repeatedly touch the UUT at strategic locations with a probe. While it is possible to perform diagnostics with a functional tester,

the costs for the TPS and diagnostic time are great due to technical limitations of the ATE. In the depots, IFTE is used to perform both functional and diagnostic tests, but the TPS costs are high.

On the other hand, testers that are optimized to perform diagnostics do so by physically connecting to most of the leads on most of the components contained within a UUT and by exercising each of those components individually to see that each works properly. This way, determination can be made as to which component(s) within the UUT have failed.

One very effective type of diagnostic tester is called an in-circuit tester. This cost of a TPS for this type of tester is usually very low because most components already have tests written for them contained in a software "library." Rather than writing the actual software code, all that is required to develop the TPS is to enter the part number of each component and have the correct test drawn automatically from the library. Although new components need to have software written for them, this software can be added to the library for subsequent application to test the same component used in different UUTs.

Even if all components test "good," a functional test may need to be conducted to see if the total assembled product also tests "good." Diagnostics testers are usually able to perform some functional testing, but often not as well as a tester designed specifically for it.

The development costs for TPSs that make a functional tester perform diagnostics may be multiples of the costs for development of the same TPSs written for a diagnostic tester. The reason for this is because the functional tester is designed to connect to the inputs and outputs of an UUT but not directly to the components on it. It takes a considerable effort to write software to test the inside of the UUT when

the tester has only minimal probing of the components on the board. [Ref. 2]

Thus, ATE choice greatly affects total cost to the weapon system because of the follow-on TPS development costs. TPS development costs are weapon system specific and usually funded out of the weapon system research and development money. Development costs vary greatly between weapon systems based on complexity. Further, the costs for developing all the TPSs for an entire weapon system can be many times the total cost of the ATE itself.

This thesis will be limited to the study of ATE selection. Cost and other aspects of TPS will only be mentioned as they contribute to understanding the depot ATE selection process.

5. Funding

One of the difficulties in getting control of these expenditures is that they are spread across multiple appropriations: Research, Development, Test & Evaluation, Procurement, and Operations and Maintenance, in addition to being funded through the Defense Business Operations Fund (DBOF). Many of these investments are embedded in various weapon systems' budgets and are not directly broken out or otherwise visible. PMs are accountable for how well their systems perform and how much they cost to procure and maintain. However, there is no requirement to specifically account for some of the special interest categories of support equipment, such as ATE. [Ref. 1]

Although there are some lists of items associated with the cost of maintenance, including support equipment, details are usually lacking. Often multi-million dollar items are listed as "test set, serial number xxxxx-xx." For any of the test equipment items listed that have associated large dollar cost, one may suspect they are automated test sets, but it would be tedious and difficult to attempt to track down and

verify, and would often require travelling to the contractor facilities to conduct a physical audit.

Within the procurement system, it is usually considered overly restrictive to dictate to a contractor "how to" perform his mission, and, as a result, little control has historically been exhibited over the specific ATE that contractors procure in support of Government work. Unfortunately, it is often these very items of equipment that eventually wind up in organic Army depots after the contracts expire. [Ref. 3]

II. BACKGROUND

In this chapter, the nature of depot-level testing and its relative place in the logistics chain will be described. Other services' ATE policies and regulations will be briefly summarized. The magnitude and nature of ATE associated costs will be identified along with several examples of some of the cost drivers.

A. MILITARY USES OF ATE

This section will answer where and why the military uses ATE. Although ATE are much more costly to procure and maintain than manual test equipment, there are several reasons why ATE are used in lieu of manual test equipment.

Some weapons systems are so technologically complex that it would either take an enormous amount of time or simply be impossible to test manually. In other cases, the skill level required to operate manual test equipment would be too high, making it imperative to reduce the required skill level through automation of the test procedure.

On the other hand, ATE can be very complex in itself and require a high skill level to operate. Even if it has been decided to use ATE to test a weapon system, it is not necessary to use it to test every UUT within the weapon system. Rather, an appropriate mix of manual TMDE, ATE and use of throw-away items should be considered. Throw-away items should be used when the cost to test and repair exceeds the cost of replacement items themselves. Delicate judgement should be exercised when deciding whether an item should be considered a throw-away because the cost of replacement items often increases dramatically after a weapon system is fielded and production has stopped. If inadequate data were procured to support development of TPSs for items because they were initially considered throw-away, it then becomes very expensive to "reverse engineer" and develop TPSs after the

fact. The maintenance alternatives need to be carefully considered during the Logistics Support Analysis process.

For the sake of this paper, there are three places where test equipment is used: field, depot and factory. Field and depot testing are done for maintenance purposes and are similar in nature but done to different levels of complexity, with depots being the highest degree of complexity. Factory testing is done for acceptance purposes and is different from the other two types, as I will explain. However, as far as level of difficulty, factory acceptance testing and depot testing have similar degrees of complexity.

Field-level testing is defined as any level of maintenance that is lower than depot, whether intermediate or organizational. In the field, maintenance is usually performed by replacement of "black boxes" or entire printed circuit boards (PCB) and, less often, replacement of soldered-in piece parts. Field ATE needs to be able to isolate faults to the failed "black box" or PCB in most cases. In contrast, depot-level diagnostic testing, which can be either organic or contract, involves a higher degree of complexity and sophistication than the field. At the depot, the "black boxes" and PCBs are repaired by replacement of individual integrated circuits or by some other complex adjustments. The depot ATE needs to be able to isolate faults to the smallest part that has failed.

Whereas factory testing can be similar in complexity to depot testing, the ATE differ in nature in that the factory ATE designs are optimized to be able to perform the type of tests that are needed for manufacturing processes in lieu of maintenance and repair processes. This optimization is done by way of trade-offs that result in a tester that is more capable of determining that the overall weapon system under test indeed functions as specified, but at the expense of not being able to determine what has failed if it does not.

Factory tests are performed to determine that items coming off the production line are "functioning" properly.

In contrast, diagnostic testing is performed in order to fault-isolate broken components within weapon systems, as is required in maintenance and repair processes. Although factory ATE are often applied to fulfill maintenance diagnostic requirements, they seldom do a very good job due to the fact that they were designed for other purposes. The reason why factory ATE is often applied to diagnostic testing will be covered later. [Ref. 2]

B. COMMERCIAL VERSUS DEVELOPMENTAL ATE

ATE are very costly to develop, procure and maintain and usually require costly computer upgrades throughout their life. Further, if the Government chooses to develop its own versus buying commercial off-the-shelf (COTS) testers, then the Government assumes full responsibility for configuration control and all upgrades to protect from obsolescence or to accommodate future technologies. However, if multiple weapon systems share the same military-developed ATE, these support costs get spread around and the cost per weapon system is reduced as is the overall cost to the Government. Next I will summarize advantages and disadvantages of commercial versus developmental ATE before exploring military policy.

1. Commercial Off-The-Shelf ATE

COTS ATE hardware have many advantages and some disadvantages. They are generally much less costly to procure than the military-developed items. There is fierce competition among vendors. This, in turn, causes these commercial vendors to have a good deal of customer focus and to produce user-friendly, well supported products that have widespread use in the commercial applications.

Within the commercial electronics manufacturing industry, firms themselves utilize these COTS ATE to test their own

products. Herb Brown from the Institute for Defense Analysis (IDA) said in a recent telephone interview that IDA has discovered that private industry is using commercial in-circuit testing to diagnose faults and "hot mock-up" to assist diagnosis, perform adjustments and perform final checkout. [Ref. 4] This is very much the philosophy that depots have been pursuing. [Ref. 3]

Hot mock-up is merely the technical term for saying that an known, good end-product is used to plug in the repaired component in lieu of functional testing. Hot mock-ups are specifically not authorized in organic depots. Procedures are in place to allow exception to this policy by applying through the Deputy Executive Director for TMDE (DEDT) to Headquarters, DA, Deputy Chief of Staff for Logistics. However, granting of these waivers for hot mock-up is rare. [Ref. 3]

Many ATE vendors have been in business for many years and have excellent records of client support. Many have even established support groups and have periodic meetings to discuss problems and desirability of future upgrades.

One of the downfalls of too-frequent upgrades can be excessive cost. An ATE upgrade can cost many times more than simply the replacement costs of obsolete computers or components such as internal test equipment. In fact, upgrades to ATE, especially developmental ATE, often require the TPSs that run on them to need modification, sometimes extensive, to order to work. This is far from a trivial expense in both time and money. Following are two contrasting cases of upgrades to ATE, one for developmental ATE and one for COTS ATE.

The IFTE, a developmental item, was designed to be an upgrade to its predecessor, the EQUATE. During acceptance tests of the IFTE, it was determined that the EQUATE TPSs did not work with the IFTE as originally planned. It took 70% of the EQUATE TPSs original development costs to make the TPSs

work on this upgrade, the IFTE. As of 1986, the Army had over $7 billion invested in EQUATE TPSs. These TPS costs were huge when contrasted to the less than $150 million hardware costs for the Army's 150 EQUATEs. Needless to say, the Army did not immediately pursue conversion of all the EQUATE TPSs because of the much larger than expected conversion costs.

However, many of the upgrades to COTS ATE are designed so that existing TPSs will work on the upgraded models without major reinvestment by the users. This has become a major competitive factor among rival firms. Commercial customers usually select firms that provide maximum "upward compatibility" of TPSs, as this important feature is called.

The depots, through best value contracting methods, awarded a contract to Hewlett Packard for an in-circuit-combinational-tester. This contract had provisions for upgrading the ATE as technology progressed via a "technology insertion clause." Although this tester has undergone several upgrades, the TPS conversion costs have been minimal, on the order of a few percent of the original costs. This contrasts sharply with the 70% conversion costs for the Army developmental ATE.

Development, configuration management, and other support costs of COTS ATE are spread among all the users, which include many private sector firms in addition to Government users, thus greatly reducing the costs for the Government. TPS development costs are also usually much less for COTS ATE than for developmental ATE, plus the TPS development environment usually has more user-friendly features. [Ref. 3]

A TPS development environment consists of computer workstations, software and other peripheral equipment that facilitate writing code that becomes part of a TPS. TPS writing is a time consuming process with much potential for cost savings if efficiencies are introduced.

When an item is hardened for use in harsh military environments, the process is called "ruggedization," and the item is referred to as a "ruggedized" item. Later in this chapter, ruggedized COTS ATE will be briefly discussed. Commercial ATE do not normally meet military standards for ability to withstand harsh environments without ruggedization, which can be accomplished via special modifications. Nonetheless, non-ruggedized COTS ATE do work fine in depot and factory environments and have no problem technologically testing most military electronics.

For these reasons, the services are often turning to COTS ATE. Curt Alway wrote the following in his article, "ATE Market Benefits from DoD Cost Cutting," published in the September 1992 issue of Defense Electronics magazine. [Ref. 5]

> One repercussion of DoD downsizing is the more prominent role of automatic test equipment (ATE). The Air Force, in particular, is streamlining maintenance and testing on both old and new platforms to bring down costs and increase efficiency. ... In all these applications, the Air Force is turning to commercial ATE vendors to save money and avoid being put in the position of having only one source for parts and equipment.

Sheila Galatowitsch wrote the following in her article, "Buying the Solution," published in the February 1993 issue of Defense Electronics magazine. [Ref. 6]

> Back in the good old days (circa 1980), major defense contractors could afford to maintain standing armies of test and software engineers who practiced the time-honored method of building proprietary test systems component by component and developing custom programming unique to a system. Ensuing world events and the recent recession profoundly altered this traditional scenario and changed both users and vendors.

In the new world order, users are less interested in boxes that have a db or a Mhz enhancement or are slightly cheaper. They want to solve specific test problems with boxes that allow complete testing. The answer, in many cases, is increasing use of VXI standard, commercial off-the-shelf (COTS) test equipment, versatile test interfaces and more integrated software. This new solution is not only cheaper, but the hardware typically goes together more rapidly and the test system is up and running sooner.

Industry is suffering through a downsizing itself, has been quick to respond to the changes in order to remain competitive. "If you want to survive, you have to be more in line with what the customers are looking for," one vendor said. The more "solutions" a company offers increases sales and decreases the cost to the user to develop the test system.

2. Developmental ATE

Developmental ATE has the advantage of being designed specifically to the military requirement. It is appropriately hardened for operation in the field. If commercial ATE cannot perform in field conditions, and if ATE is necessary at that level of maintenance, then development or ruggedization of COTS ATE becomes the only alternative. However, in a depot environment, there is no need for military hardening or ruggedization. Money spent on a ruggedized tester for depot use is wasted as far as the hardening is concerned. [Ref. 3]

Developmental ATE generally encompasses two types: general purpose and special purpose. One of the big cost drivers and problems for older systems is special purpose ATE. These one-of-a-kind testers have enormous relative costs considering that they only support a single weapon system. Also, protection from obsolescence is very expensive because special purpose ATE design data is often either proprietary or inaccessible because the Government did not procure

documentation or the original design engineers are no longer available for consultation.

Special purpose ATE is often a result of maintenance contracts with the production contractors who originally produced the weapon system. These contractors often perform Interim Contractor Logistics Support prior to transitioning to an organic depot. Contractors quite often adapt the functional ATE that they were using during production for acceptance testing, to perform the diagnostics now required during maintenance. They usually do so under a performance specification from the Government to perform this maintenance work. It makes sense for them to use the ATE that was left over from the production run because they already own it and because they have people who are familiar with it. Even though it seldom makes sense from a weapon system life cycle standpoint, it does make sense from the standpoint of the contractors. The contractors know that the plan is to transition the maintenance to an organic depot within a few years at most, and thus have no incentive to develop more cost-effective ATE for their short term use. Further, they either transfer the special purpose ATE to the depots for free, if the Government owns the ATE, or they sell the ATE relatively cheaply compared to the commercial alternatives, because they no longer have a use for them. [Ref. 3]

General purpose developmental ATE, while serving the legitimate purpose of filling a niche that commercial ATE does not, is also very expensive to develop, procure and maintain. The Government is responsible for all development, configuration management and upgrade costs. However, as more weapon systems share a common developmental ATE, each benefits in the way of decreased costs due to sharing of the configuration control and management and better weapon system logistics due to the existence of more items of ATE. [Ref. 1]

3. Ruggedized Commercial Off-The-Shelf ATE

As previously stated, in a depot, there is no need to ruggedize equipment. Depots, by their nature, are at a fixed location and provide the ATE with a controlled environment. However, in the field, this is not the case. Ruggedization is necessary for field use and involves beefing up the ATE or adequately sheltering it so that it can withstand the rigors of field conditions, which might include vibration, shock, thermal, humidity and other environmental hazards.

In some cases, COTS ATE meets all field requirements except for the fact that it is not ruggedized. In these cases, it might be more cost effective to ruggedize the COTS ATE than to develop an entirely new ATE. In contrast with the field, if ATE were ruggedized before being installed in a depot, this would be a waste of money.

C. MILITARY POLICY

Each of the services worked independently and without any joint coordination to develop their own general purpose ATE and establish service policies requiring use of that developed ATE. During the late 1970s and into the 1980s, the Navy developed a system called Versatile Automatic Shop Test (VAST) and the Army developed Electronic Quality Assurance Test Equipment (EQUATE) which have been superseded by Consolidated Automated Support System (CASS) and Integrated Family of Test Equipment (IFTE) respectively.

In fact, this overall lack of jointness or coordination among the services has been a source of concern for many Government agencies as stated in the following quote from a 1994 report written by the Institute for Defense Analysis. [Ref. 1]

> In the past year, DoD ATS management has been the subject of 4 DoD Inspector General (IG) audits, three General Accounting Office (GAO) audits, and

> more recently a House Armed Services Committee (HAC) special investigation. These have all reflected a lack of DoD policy or coordinated approach to automatic test systems....

1. Navy Policy

The Navy has a policy requiring standardization as much as possible using the CASS that the Navy developed. Under this policy, development or acquisition of non-CASS ATE requires approval from the Assistant Secretary of the Navy for Research, Development and Acquisition (RD&A) approval. [Ref. 7]

2. Air Force Policy

The Air Force has a regulation requiring use of the Modular Automated Test Equipment (MATE), a flexible system that the Air Force developed that was sound in concept but never gained widespread use, probably due to a lack of enforcement. Waiver authority to utilize ATE other than MATE was decentralized to the acquiring major commands and was granted frequently. More recently, the Air Force has established new policy to use existing DoD-inventoried ATE or common commercial ATE. It is unknown how this will eventually be implemented because the Air Force has recently undergone major reorganization. [Ref. 8]

3. Army Policy

The Army has a regulation requiring use of IFTE. The portions of that regulation that pertain to ATE are at Appendix B. Waiver procedures are established to allow waivers for cost, schedule or performance reasons. These procedures are implemented by an Army Executive Agent established organization called the United States Army Test, Measurement, and Diagnostic Equipment Activity (USATA) which provides service-wide management, policy setting, and control. [Ref. 9]

D. ATE LIFE CYCLE COSTS

This section will discuss qualitatively the costs associated with the various phases of ATE and weapon system life cycle while focusing on major cost drivers. Attention is paid to alternatives that reduce or increase cost plus the associated technical trade-offs.

Logistics is a major cost driver for most weapon systems' fieldings. The more complex those systems become, the higher the requirement for support equipment for maintenance. Thus the overall cost attributed to those weapons increases and logistics becomes more difficult. As such, it is desirable to require as few a number and low a dollar value of support equipment as possible and practical. If multiple weapon systems could share the costs associated with utilizing an ATE, the cost per weapon system could be reduced. Thus, in this regard, it is desirable to have multiple weapon systems share common major ATE. Not only does this drive costs down, but it provides a tactical advantage by allowing each different weapon to be supported by a single common piece of test equipment.

When ATE are deployed for use at multiple locations, this provides additional support to all of the weapons it is able to test, not merely the one it was procured to support. Thus, this rationale forms much of the basis to the call for standardization of ATE in the field.

1. Development of ATE

ATE development takes the same form as development of any other weapon system. According to recent estimates, development costs for standard ATE that test multiple weapon systems are typically the same as those for a single weapon system ATE. These estimates indicate that for every given weapon system added to the list of supported systems for a given ATE, the development costs increase a mere 5% in order

to cover the cost of adding test capability to accommodate the additional new technical requirements. This results in a 95% developmental cost avoidance when compared to a completely new developmental ATE. [Ref. 1]

TPS costs are usually as significant as the hardware ATE costs and can vary between different brands of ATE by an order of magnitude. In fact, selection of which ATE to use sets the stage for very large future TPS expenditures in both development and maintenance of the TPS.

The Institute for Defense Analysis, in an August 1994 report, studied five modern major weapons systems from each service, Army, Air Force and Navy. Within these fifteen weapon systems, over 100 unique special purpose ATE types were identified with total equipment numbers exceeding 2300. These figures only include ATE associated with the major weapon systems and exclude ATE associated with major subsystems such as electronic warfare pods. In some cases, such as with the Sidewinder Missile Guidance and Control Section, two services use different ATE to test the same weapon component. [Ref. 1]

2. Procurement of ATE

Procurement of additional quantities of ATE once development is complete results in unit cost reductions due to increased order quantities. The fixed overhead will be spread over more production items and production will become more efficient as movement is made up the learning curve. For these reasons, all major ATE program management offices seek to maximize their number of customers, sometimes even if it is not in all their customers' best interests. Within the Army, the office responsible for development of the Army standard ATE also plays a vital role in approving waivers from that standard.

3. Operation and Support of ATE

Operation and Support should be a major consideration when selecting an ATE. As was stated earlier, as an ATE ages, the ATE hardware needs to undergo upgrades to keep the ATE operational. In some cases, just the computer or some of the test instruments are replaced. In other cases it is more effective to simply replace the entire ATE with a more modern and supportable one. However, the TPS costs of doing either can be very large.

The Navy is in the process of rehosting TPS from six aviation testers to CASS at a cost of $800M. Even with this large TPS "rehost" cost, this upgrade is considered cost-effective because of the large support costs of the six testers.

Work has been done to reduce the cost of rehosting TPSs. However, even with current technology, the cost is usually great and the technical effectiveness somewhat lacking. During the initial acceptance tests of the Army's IFTE, which was actually designed to be able to "capture" its predecessor, the EQUATE's TPSs, it was determined that it took 70% of the original TPS investment costs to make them work on the IFTE, and even then they did not work as well as they did on EQUATE for which they were written. TPSs are optimized to take advantage of features available on specific design of ATE and are not easy to make transportable to alternate ATE.

Many COTS ATE vendors recognize this large cost to maintain TPSs and are targeting their market with new generations of ATE that offer maximum upward compatibility of TPSs from previous generations. This is major selling point for using COTS ATE.

III. ORGANIZATIONS AND MISSIONS

This chapter will describe the roles and responsibilities of Army organizations involved with acquisition of depot ATE. Although it will not provide a detailed list of all their missions and functions, it will summarize those that pertain to this thesis and give enough information to gain insight into how they are organized.

The organizational structures of many of the Army organizations responsible for depot-level selection and use of ATE is undergoing, or has undergone, extensive change from both internal initiatives and Base Realignment and Closure (BRAC) actions. Although it would not serve the objectives of this thesis to explain all the organizational changes in detail, some of these changes cannot be ignored. It is important to note that these reorganizations, realignments and closures are not due to changes in ATE management philosophies or practices but rather from efforts to streamline and downsize the Army overall. It is also important to recognize that the trend in the DoD industrial base is toward fewer, more cost-effective installations.

This trend has forced all depots to be in keen competition with each other and the private sector. As a result of competition, many of the depots are closed, or in the process of being downsized or closed. Others are being studied for possible closure. All installations have a need to operate as cost-effectively as possible if they are to remain open in the future. This thesis will further explore this motivational factor in the next chapter. The importance of keeping costs down to remain competitive cannot be overstated.

The reader is cautioned to bear in mind that the currency of the data in this thesis is mostly as of 1994, as it is likely that sweeping changes will continue to occur to the entire DoD industrial base for quite some time. It would go

beyond the scope of this thesis to speculate on the potential nature of those changes, but it is fair to state that volatility and closures are likely to continue.

Within this entire study, the specific depots and Major Subordinate Commands/Program Managers (MSCs/PMs) differ based on what weapon system and commodity is in contention. However, no matter which depot and which MSC/PM, there are always three basic players.

Understanding these three players is vital to the gist of this thesis. The three players that are always involved in depot ATE selection are: 1) U.S. Army TMDE Activity, 2) U.S. Army Depot System Command, and 3) Major Subordinate Command/Program Manager. Following is a description of these players' missions as they pertain to ATE acquisition and management. Some of the detail goes beyond that necessary to understand the ATE issues, but it may be necessary in order to follow what is happening during the numerous organizational realignments.

A. U.S. ARMY TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT ACTIVITY

The U.S. Army Test, Measurement, and Diagnostic Equipment (TMDE) Activity (USATA) is the organization that has DA-level responsibility to set policies, write regulations and enforce those regulations and policies. USATA only came into existence in its present form in 1991. I will give a brief history of USATA's past. The current organizational chart for USATA is at Figure 3-1. [Ref. 9]

In 1982, due to Congressional interest in TMDE management in the Army and a resulting major study, the Secretary of the Army designated the Commanding General (CG) of AMC as the Department of Army TMDE Executive Agent. The CG, AMC, in turn, designated the Deputy Commanding General for Materiel Readiness, as the Executive Director for TMDE. This Executive

U.S. ARMY
TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT ACTIVITY
REDSTONE ARSENAL, ALABAMA 35898-5400

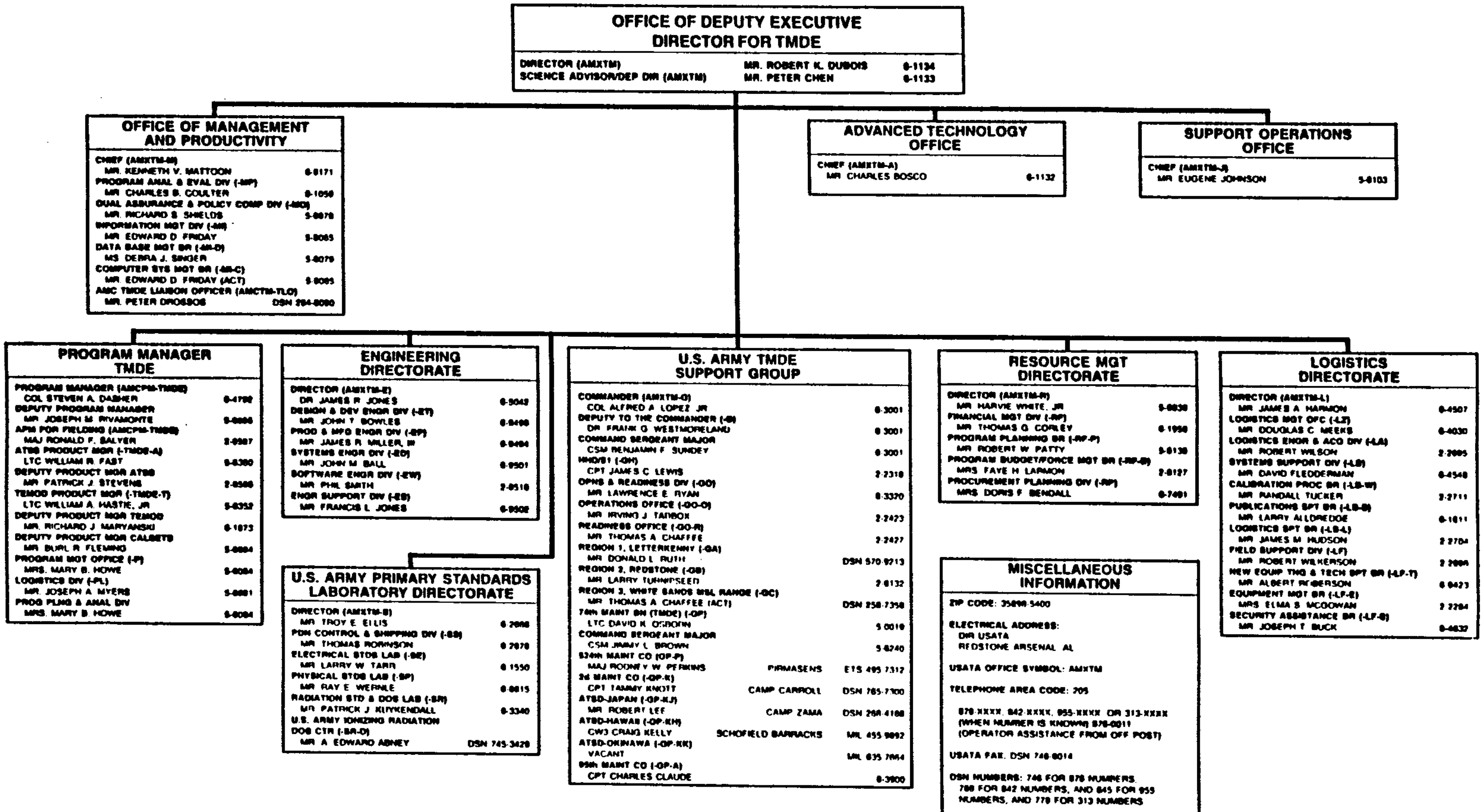


Figure 3-1. USATA Organizational Chart.

Director for TMDE created a Deputy Executive Director for TMDE (DEDT) and put him in charge of a newly created office responsible for TMDE management. Whereas the Executive Agent and the Executive Director are dual-hatted positions within AMC, the DEDT is a full time position responsible for Army TMDE management, supported by a staff office. The DEDT was put in charge of three other organizations that will be treated as part of the DEDT for the sake of this study. These organizations were:

1. The U.S. Army Central TMDE Activity previously located in Lexington, Kentucky, is now the Logistics Directorate in Huntsville, AL. Enforces the Army's TMDE policies and maintains data bases containing lists of TMDE in the Army.

2. The U.S. Army TMDE Support Group continues to be located in Huntsville, Alabama. Calibrates and provides repair support for Army TMDE.

3. The Program Manager for TMDE previously located in Fort Monmouth, New Jersey, is now part of USATA in Huntsville, AL. Develops and manages modernization items of TMDE and ATE. Manages technical issues concerning TPS and ATE.

In 1991, the Army, under direction of the DEDT, consolidated its TMDE management, combining all three organizations into one location, Huntsville, Alabama, and named the consolidated organization USATA. The DEDT moved to Huntsville and is the person in charge of running this organization.

For ease of discussion, we will refer to this organization as USATA throughout the study even though USATA only officially came into existence in 1991. It would be needlessly confusing to change titles on chronological basis since this remains the same basic organization with the same missions. Also, little attempt will be made to differentiate between any of the organizations that merged to become USATA

as the DEDT was always in control. Even prior to USATA's establishment, the other organizations' involvements in ATE issues were at the DEDT's direction.

B. ARMY MATERIEL COMMAND

All the organizations involved with depot ATE selection, except for the Program Managers, are organized under the Army Materiel Command (AMC). USATA, even though organizationally an activity of AMC, has a DA-level charter to manage ATE for the entire Army. The organizational chart of Headquarters, AMC is at Figure 3-2.

AMC is a major command of the United States Army that functions through major subordinate commands (MSC) to accomplish its mission of life cycle management of Army material. It has been in existence since its establishment in 1962 by then Secretary of Defense, Robert McNarmara, when it was established to centralize and standardize material and logistics functions and improve efficiency and economy.

AMC is a large organization that had over 126,000 employees, 90% civilian, at its peak in the mid 1980s. The number of employees currently in AMC is approximately one half the previous numbers and the size continues to go down as the DoD continues to realign and reduce its support infrastructure. The Headquarters AMC had approximately one thousand people at its peak. Reductions are due in large part to consolidations and realignments that resulted in both downsized installations and in closures.

Although AMC had been responsible for all life cycle management of weapon systems, this changed in 1986 when the Program Executive Officer (PEO) structure was established outside the AMC chain of command and all major PMs were moved from AMC to this new structure. Still, PMs continue to rely on AMC's MSCs to perform the logistics actions necessary to develop, operate, support and field their systems. This is

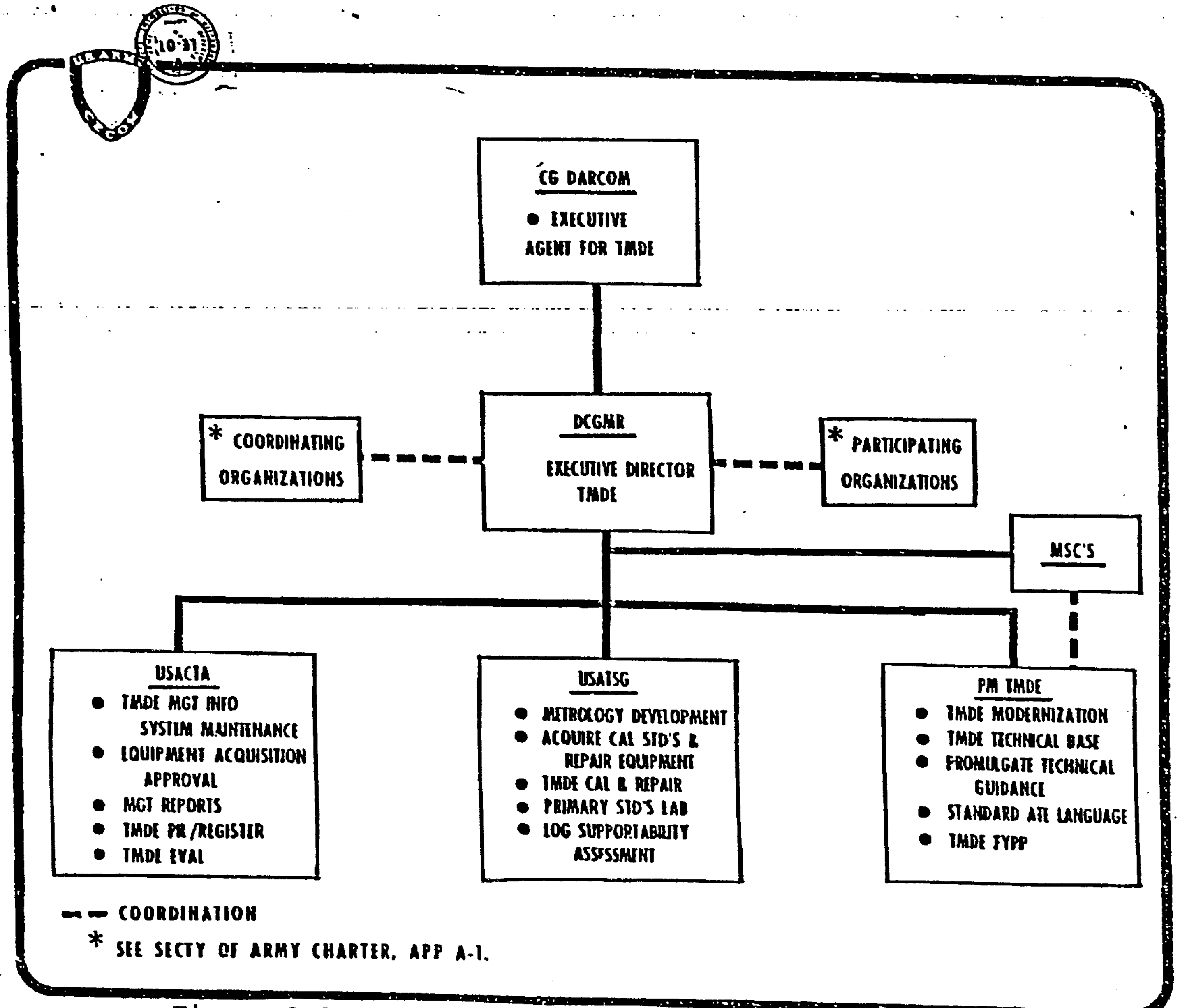


Figure 3-2. AMC Organizational Chart of TMDE Functions.

being accomplished through matrix management and is made practical by the fact that most PMs remain collocated with the MSC that supports them.

C. AMC MAJOR SUBORDINATE COMMANDS

AMC major subordinate commands (MSC) are organized into functional commodities, with the exception being DESCOM, which is explained in the section on DESCOM, below. This commodity orientation will become clear as I describe each of the MSC organizations below. It should be noted that depots themselves are also commodity-oriented and it is primarily one or two depots that support each of the MSCs or PMs. An organizational chart of AMC showing the MSCs is at Figure 3-3.

1. Armament, Munitions and Chemical Command

Throughout the period of this thesis, Armament, Munitions and Chemical Command (AMCCOM), located in Rock Island Illinois, was responsible for providing and performing matrix support to PMs. AMCCOM also provided assistance in research and development, engineering, procurement, and material readiness functions for conventional and nuclear weapons, ammunition, chemical warfare/chemical biological defensive systems/material and fire control systems. The mission area where depot ATE needed to be procured and applied was in support of fire control maintenance, armament electronics and wiring harnesses.

Due to BRAC 91 public law, AMCCOM and DESCOM missions will change, although not in areas that substantially affect this thesis. Further, the period that this thesis covers is prior to the date this BRAC action will have any substantive effects. Although the organizational change will not substantially change the management of ATE, I will briefly explain the effects of BRAC 91 on AMCCOM and DESCOM.

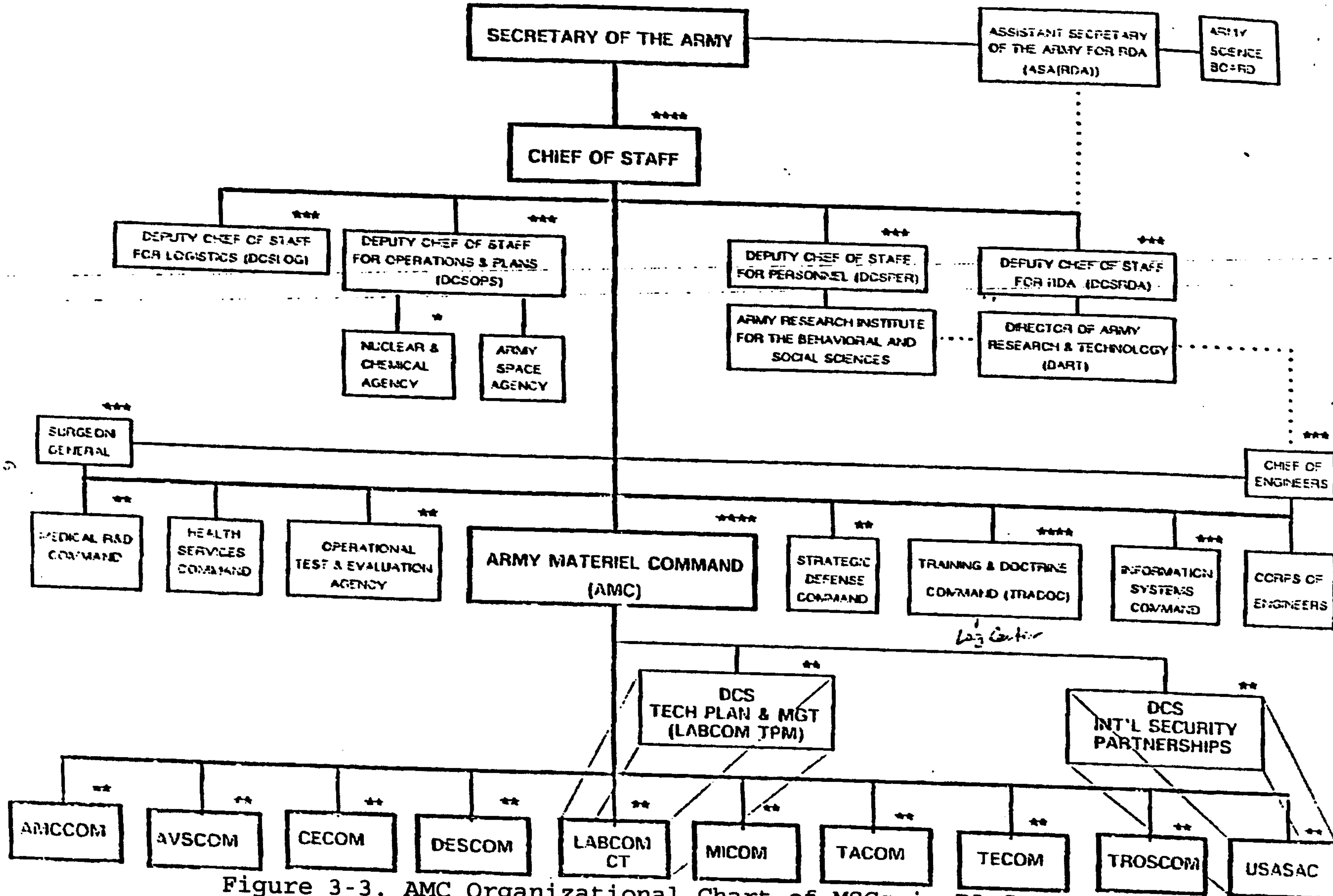


Figure 3-3. AMC Organizational Chart of MSCs in DA Structure.

In late 1995, AMCCOM will merge with DESCOM to form a command responsible for managing all Army industrial complexes. This resultant command, the Industrial Operations Command (IOC), will be responsible for the depots currently managed by DESCOM plus the ammunition plants and arsenals currently managed by AMCCOM. The IOC will command Army depots, depot activities, arsenals, ammunition plants and other industrial activities. The IOC will perform ammunition procurement, installation and environmental management, and provide centralized management and decentralized execution of ammunition and weapon systems production, maintenance and storage.

The IOC will be headquartered in Rock Island, Illinois, where AMCCOM is located today. All other AMCCOM missions, other than the procurement and management of ammunition, will transfer to other commands, primarily to the Tank-Automotive Command. Management of the systems that require use of ATE will transfer to TACOM.

Whether managed by TACOM or AMCCOM, most of those systems, except for fire control, are supported by either Red River Army Depot, Anniston Army Depot or Letterkenny Army Depot. The fire control systems are mostly done at Sacramento Army Depot, which is in the process of being closed by a BRAC action. The fire control systems are slated to be transferred to the Air Force at Sacramento Air Logistics Center as a result of a public-public competition between the Army and Air Force, a substantial loss for the Army. [Ref. 10]

2. Aviation and Troop Command

The Aviation and Troop Command (ATCOM), located in St. Louis, Missouri, is responsible for providing and performing matrix support to PMs. It is also responsible for research and development, and material readiness of all Army airframes and troop support items such as clothes, food and topographical gear, the latter of which has electronics

components that utilize ATE in the maintenance process. Army helicopters utilize ATE for diagnostic functions in the avionics, control systems, wiring harnesses and in the testing of the turbine engines and transmissions.

ATCOM aviation systems are primarily supported by Corpus Christi Army Depot and the troop support systems by Tooele Army Depot. Because the maintenance part of Tooele Army Depot is being closed by BRAC, most of the electronic troop support items that require electronic testing are being transferred to Tobyhanna Army Depot. [Ref. 11]

3. Communications and Electronics Command

The Communications and Electronics Command (CECOM) is located in Fort Monmouth, New Jersey and is responsible for providing and performing matrix support to PMs. CECOM is responsible for research, development and material readiness of command, control and communication systems. Most of the CECOM items are technologically complex and utilize some form of automated testing in the diagnostic processes. CECOM systems are primarily supported by Tobyhanna Army Depot. Before the BRAC closure of Sacramento Army Depot, which began in 1991 and which is almost complete, and for much of the timeframe of this thesis, CECOM systems were split between Sacramento Army Depot and Tobyhanna Army Depot. In the future, most new CECOM systems will either be supported by Tobyhanna Army Depot or will be competed with private industry and other services. [Ref. 12]

4. Depot System Command

The Depot System Command (DESCOM), headquartered in Chambersburg, Pennsylvania, was established in 1976 to provide corporate management and oversight of all of the Army depots and depot activities. The term DESCOM refers to the entire command including all the subordinate installations, whereas the term HQDESCOM (Headquarters, U.S. Army Depot System Command) refers to the headquarters only.

It is not important to distinguish between depots and depot activities for the sake of this thesis, but the major difference is that a depot activity relies on a parent depot to perform many of its planning and administrative functions. All of the ATE cases analyzed in this study were acquired for full depots.

DESCOM is different from all the other AMC MSCs in that it is not responsible for research and development or for providing matrix support to PMs. DESCOM's mission is one of providing depot-level maintenance support to the other MSCs and the PMs. In some instances DESCOM does perform research and development or fabrication work, but this is performed on a reimbursable basis in support of other organizations' programs and is not considered to be managed by DESCOM.

HQDESCOM manages the depots and workload distribution among those depots, and performs all the tasks necessary to establish and maintain adequate capability and capacity to perform that work. This includes acquisition and management of all the items of ATE in the depots. HQDESCOM serves as a corporate headquarters for depots and, in addition to setting corporate policy, serves as the advocate looking after the depots' well-being and competitiveness within DoD and the private sector.

As stated in the section on AMCCOM above, DESCOM will combine with AMCCOM later in 1995 to become the IOC, which will be headquartered in at Rock Island, Illinois. Its mission will remain the same with regards to depots. [Ref. 13]

5. Missile Command

The Missile Command is located near Huntsville, Alabama at Redstone Arsenal and is responsible for providing and performing matrix support to PMs. MICOM is responsible for research, development and material readiness for all Army missile and rocket systems.

Most of the MICOM missile and rocket systems are supported at either Anniston Army Depot or Letterkenny Army Depot. However, as a result of BRAC, all of these will transfer to Letterkenny Army Depot in the near future. As stated previously for the AMCCOM systems, many of the missile fire control items that were supported at Sacramento Army Depot have been transferred to Sacramento Air Logistics Center of the Air Force as a result of winning a public-to-public competition. The remaining MICOM systems are supported in part at Red River Army Depot or Corpus Christi Army Depot as subsystems of other major weapon systems. [Ref. 14]

6. Tank-Automotive and Armaments Command

The Tank-Automotive and Armaments Command (TACOM) is headquartered in Warren, Michigan. Throughout the period of this study, TACOM stood for Tank-Automotive Command. It is only in 1994 that the "Armaments" was added to the name. The part of AMCCOM that procured and managed the armament systems for the Army was transferred to the TACOM organization as part of a BRAC realignment but will remain in Rock Island as the Armament and Chemical Acquisition and Logistics Activity of TACOM.

During the time period of this study, TACOM was responsible for providing matrix support to PMs. It also provided for research and development, procurement and material readiness of all tracked and wheeled combat and general purpose vehicles. Many of the vehicle mechanical components required use of ATE in the form of dynamometers or transmission test stands. Also, all vehicles contain wiring harnesses that require automated testing.

Even though management of the armaments part of the vehicle has now been moved from AMCCOM and added to TACOM, this will not change the basic relationships in management of ATE. [Ref. 15]

D. DESCOM DEPOTS

As previously stated, the U.S. Army Depot System Command headquarters is located at Letterkenny Army Depot, Chambersburg, Pennsylvania, and is a major subordinate command of AMC. In the mid-1980s it commanded and controlled the Army's thirteen depots and ten depot activities, totaling over 40,000 workers. Within this structure, there were eight maintenance depots where ATE was used. The other depots and depot activities served specialized functions other than maintenance, such as the supply mission, which has recently been realigned to Defense Logistics Agency. The information in this section and its subsections was gotten from the DESCOM Organizations and Functions and was updated by telephone interview with George Turek, HQDESCOM. [Ref. 3, 16]

By 1994, the command was considerably smaller due to workforce reductions, mission realignments, and depot closures. It contained a total of eight depots and six depot activities with approximately 20,000 workers. This structure is likely to see further reductions in the near future due to continued defense downsizing.

On October 1, 1995, DESCOM will officially combine with the munitions part of AMCCOM that manages the ammunition plants and arsenals to form the Industrial Operations Command (IOC). The IOC will be the largest subordinate command in AMC and, in 1995, will employ about 24,000 civilians, 300 military and 13,000 contractor employees. Its annual civilian payroll is $1.1 billion. The IOC, headquartered at Rock Island Arsenal, Illinois, will streamline the functions for industrial operations within the Army by placing them under a single command.

This thesis will address the situation that existed before the IOC was created and when the ATE-acquiring depots were still intact. The reason for this is because the IOC has

not yet been established and because all the data that is available is from a time period prior to IOC establishment. This study will still be valid for future ATE acquisition decisions because depots' interests have not changed, nor will the corporate philosophies of the IOC headquarters. Although some of the depots that were large users of ATE are closed or being closed, the missions that they supported will be transferred to other installations along with the ATE in most cases.

The depots are organized much as the commodity MSCs with logical groupings of similar work. Following is a summary of depot missions that pertain to ATE acquisitions that were reviewed during this study. See Figure 3-4 for an organizational chart showing the installations within DESCOM.

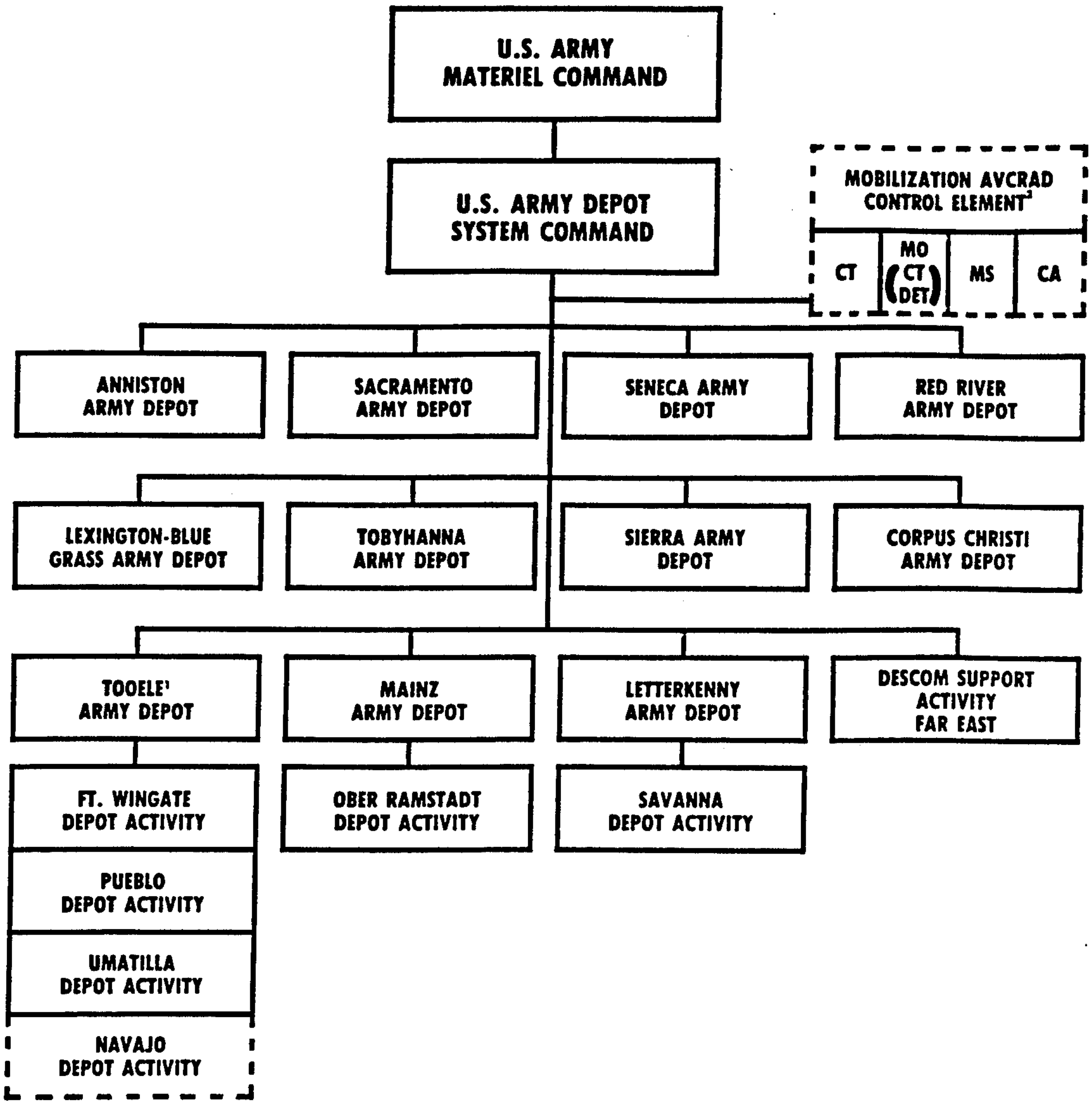
1. Anniston Army Depot

The primary mission of Anniston Army Depot (ANAD), is the repair, overhaul, and conversion of the Army's tracked combat vehicles, including their engines, transmissions, some fire control systems, and other components. ANAD is located at Anniston, Alabama, about 50 miles east of Birmingham. Most of the maintenance workload is concentrated on the M60-series tank and the M1 Abrams main battle tank. In addition to all the heavy duty metal and machine shops needed to work on tanks, ANAD has facilities to test and repair all the complicated fire control, wiring and other electronics, plus computerized engine test cells for both diesel and turbine engines.

Other missions included the repair of some optical and electronic fire control subsystems plus many missile systems, such as the Hellfire, Multiple Launch Rocket System, TOW, Lance, Dragon, and support equipment such as Land Combat Support System. The missile items from ANAD are being realigned to Letterkenny Army Depot as a result of BRAC.

Chapter 29

U.S. ARMY DEPOT SYSTEM COMMAND DEPOTS/DEPOT ACTIVITIES/SEPARATE REPORTING ACTIVITIES



NOTES: 1. Tooele Army Depot maintains surveillance monitoring of conventional ammunition operations and property of Navajo Depot Activity (NADA). Peacetime operations at NADA are performed by the Arizona National Guard. Upon mobilization, NADA returns to DESCOM under the direction and control of Tooele Army Depot.

2. Upon mobilization, the MACE is established as a separate HQ within DESCOM with command and control over the four AVCRADs in CONUS. The AVCRADs are located at Connecticut, California, Mississippi, and Missouri, with Missouri deploying to OCONUS-Europe. The Missouri facility will be back-filled by the Connecticut Detachment. The Commander, MACE, is a member of the DESCOM Command Group and will report directly to the Commanding General, DESCOM, under mobilization conditions. A separate HQ will be physically maintained for MACE. MACE staff personnel will work and be physically located with respective DESCOM counterparts but report to Commander, MACE.

Figure 3-4. DESCOM Organizational Chart of Installations.

2. Corpus Christi Army Depot

The primary mission of Corpus Christi Army Depot (CCAD) is the repair, overhaul and maintenance of Army helicopters, such as the UH-1 Huey, the AH-1S Cobra attack helicopter, the OH-60, the CH-47 Chinook general cargo transport helicopter, and the AH-64 Apache attack helicopter. It is located on the Gulf of Mexico and is a tenant on the Naval Air Station, Corpus Christi, Texas.

These missions require test facilities to test and repair many of the avionic systems plus computerized turbine engine test cells and facilities to whirl and sense imbalances in repaired rotor blades.

3. Letterkenny Army Depot

Letterkenny Army Depot (LEAD) is located in Chambersburg, Pennsylvania. Its primary mission at this point in time is unique in DoD. Due to a BRAC decision, LEAD is the first depot within all the services to be assigned an overall responsibility for all of a DoD commodity, in this case, tactical missiles. All services have been ordered to transfer all tactical missile workload to LEAD. Eventually more than twenty missile systems will be maintained here. At this point in 1995, approximately 50% progress has been made toward completion of this transfer. LEAD is important in that it is considered a prototype "DoD" depot of the future where all like work is consolidated into a single installation. [Ref. 17]

Additionally, LEAD is the primary depot for the Army's self-propelled and towed artillery systems, including the M109 and M110 howitzers and is working as a team with a contractor to upgrade the fleet of M109 howitzers to the M109A6 Paladin status.

4. Mainz Army Depot Complex

The maintenance portion of Mainz Army Depot (MZAD) Complex, Germany, has been closed and turned over to the German Government. However, throughout the 1980s, MZAD was very active and is included here because it played a vital support role during the period covered by this thesis. Many items of ATE were procured in duplicate, one set for the CONUS depot and another for MZAD.

MZAD was composed of eight geographically separate facilities and was responsible for providing timely and responsive support to United States Army Europe, NATO, and non-NATO customers for most commodities supported by the CONUS depots, combat and tactical vehicles, aviation, missile ground support systems, communications and electronics equipment and fabrication and repair of tires, roadwheels, tracks and related equipment. The two main facilities, Mainz-Mombach and Mainz Gonsenheim, are located in the city of Mainz on the south side of the Rhine River.

5. Red River Army Depot

Red River Army Depot (RRAD) is located in Texarkana, Texas, eighteen miles west of the Arkansas-Texas state line. It is the primary depot for overhaul of the M113, and the M2 and M3 Bradley Fighting Vehicle System armored personnel carriers, the M901 Improved TOW Vehicle, the Multiple Launch Rocket System, the Fire Support Team Vehicle, the Chaparral surface-to-air missile system, armament subsystem of the Cobra attack helicopters, Vulcan and Product Improved Vulcan, air defense gun anti-aircraft systems, and rebuild of roadwheel and tracks for the Army's tracked vehicles.

6. Sacramento Army Depot

Sacramento Army Depot (SAAD), located within the city limits of Sacramento, California, is in the process of being closed as a result of BRAC actions. It is currently operating as a depot activity and is scheduled to be completely closed

by 1997. Throughout the time period covered by this study, SAAD played a vital role as a state-of-the-art repair facility for electro-optics, including starlight night scopes, thermal imaging devices, and laser rangefinders and target designators. SAAD also repaired and maintained a variety of communications shelters and vans; Guardrail V, a combined airborne and ground communications intelligence system; Firefinder, a mortar and artillery locating radar system; the Remotely Piloted Vehicle, a battlefield surveillance system; gyroscopes; and electronic warfare systems detection devices.

7. Tobyhanna Army Depot

Tobyhanna Army Depot (TOAD) is located in the Pocono Mountains of northeastern Pennsylvania, near the cities of Scranton and Wilkes-Barre. TOAD performs a variety of maintenance missions for satellite communications terminals, communications shelters, and ATE. This is where the Army's standard ATE obtains most of its depot-level support. TOAD's primary mission is the overhaul, rebuild, modification, conversion, repair and fabrication of strategic and tactical communication equipment, including the VRC-12 and SINCGARS radios. TOAD is also the prime depot for repair and overhaul of the Tactical Fire Direction System and the TSQ-73 Missile Minder.

8. Tooele Army Depot Complex

Tooele Army Depot (TEAD) Complex consisted of seven locations in five states. All the maintenance work that involved the use of ATE is at TEAD proper, located thirty five miles west of Salt Lake City, Utah. Most of the depot activities under TEAD are in the process of being closed or drastically downsized. The maintenance portion of TEAD itself is being closed as a result of BRAC actions.

TEAD is responsible for overhauling the Army's tactical wheeled vehicles, power generation equipment, plus associated secondary items, mainly engines and transmissions. Much of

this work involves the use of automated dynamometers and transmission test stands. TEAD is also responsible for the Heavy Expanded Mobility Tactical Truck, the M9 Armored Combat Earthmover, and the High Mobility Multipurpose Tactical Truck. The generator overhaul mission ranges from 1.5 kilowatt to 4500 kilowatt power plants. TEAD also repairs and overhauls topographic equipment, which includes many electronic components that require ATE.

The majority of the workload from TEAD, all the transmissions, engines and generators, are being transferred to RRAD as part of the closure. The small amount of electronics work is being transferred to TOAD.

E. PROGRAM MANAGERS

Program Executive Officers (PEO) were created in 1986 to perform functions based on the Packard Commission report. PEOs oversee program execution and report to the Component Acquisition Executive, who in turn report to the Defense Acquisition Executive. The Army has 10 PEOs responsible for 32 major and 117 non-major programs. [Ref. 18]

Organizationally under the PEOs are PMs. DoD policy requires all systems acquisition processes be managed by a responsible manager and thus PMs were established. PMs are responsible for directing the development, production and initial deployment of a system, as a minimum. They manage and execute the program, report only to the PEOs for program matters and develop the program baseline. It is the PM who is responsible for integrating the efforts of all the responsible parties to assure that a supportable system is funded, fielded, and meets the users needs. PMs have only one responsibility, managing the program, and their accountability is clear. It is the PM who must maintain the big picture

perspective of the program and an in-depth knowledge of the interrelationships among its elements. See Figure 3-5 for the DoD Acquisition Authority Chain-of-Command.

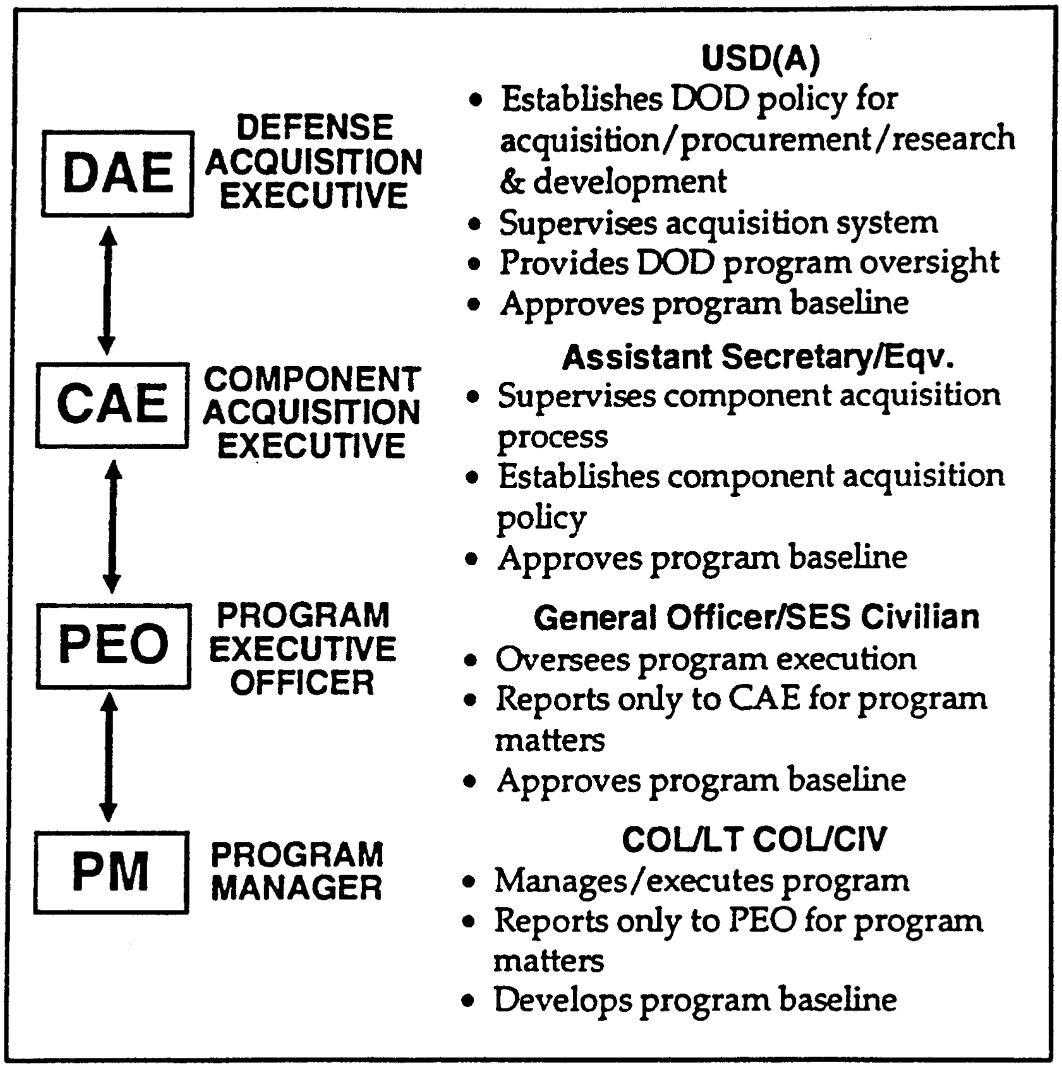


Figure 3-5. DoD Acquisition Authority Chain-of-Command.

IV. ANALYSIS

There are three basic organizations involved with depot ATE acquisition and management, each with different goals and strategies. All of these organizations have interests in controlling the ATE investments that go into depots.

Depots need to operate as a business, maintain a customer focus, operate efficiently and, above all else, survive in this world of draw-down and closure. With regard to ATE selection, this means acquiring the best equipment for the job as seen from their business perspective.

PMs need to do what is best for their weapon systems. They are accountable for their weapon systems' success, including depot-level maintenance support. This includes the ability to make trade-offs between short- and long-term maintenance methods in order to meet immediate fielding schedules. Solving short term maintenance problems might involve making commitments that result in acquisition of less effective ATE for long term application in organic Army depots. This might be in the best interests of the weapon system overall, but it is often not in the depots' best interests.

USATA needs to control proliferation of Army ATE and promote use of the Army standard ATE. USATA is chartered to control the selection of all Army ATE through the use of the waiver process. This charter gives USATA the right to be the final decision authority, which may result in less effective depot ATE being selected because of USATA's propensity to use the standard Army ATE.

This chapter will analyze the organizational goals and strategies. It will also characterize the individual depots and supported commodities. In order to gain an understanding of depots' ATE requirements, it is important to understand that the depots and commodity MSCs have different testing needs. These different testing needs usually require

different ATE. This chapter makes the case that it is not possible for a single standard ATE to be an optimal test solution for every depot and field requirement.

A. GENERAL

USATA and DESCOM deal with the selection of ATE for use in depots on a regular basis. The PMs deal with selection of depot ATE usually once in a weapon system's life. However, the people in the MSC providing the matrix support to the PM are usually the same individuals even though they represent different weapon systems over the course of time. USATA, DESCOM and the people in the MSCs have developed an understanding or agreement over how depot ATE is handled.

USATA and DESCOM have come to agreement that, if depots are not going to use the Army standard ATE, then at least they should standardize across all depots. While this standardization across all depots is possible to some extent, there are problems with its wholesale application. Depots are commodity-oriented and have very special equipment requirements for much of their specialized workload. Whereas this commodity orientation precludes standardization to some extent, certain ATE can be applied across all commodities. This is especially true for purely electronics components.

Although it has not always been the case, USATA currently recognizes that DESCOM's requirements are different than those of the field. As such, USATA has requested that DESCOM develop an informal standard "family" of depot ATE. The policy still requires depots to use the standard ATE, but special consideration is given for a waiver request for an item from the depot family of ATE.

This family includes ATE that fulfill various niches in testing, including a desktop digital tester that costs $50K, a high end state-of-the-art COTS combinational tester that can perform both diagnostics and functional testing costing about

$500k, a cable-harness tester, and the Army standard ATE which is the IFTE that costs just under $2M. Two of the depot only COTS items were competed as best value, multi-year requirements contracts good for 5 years. This established standardization for an adequate period of time without locking in obsolete technology.

Occasionally, PMs/MSCs submitted waiver requests for depot ATE without coordination from DESCOM. Recently, and now included officially in AR 750-43, USATA requires coordination of waiver requests with DESCOM for depot ATE. Regardless of whether coordinated, depots, PMs and USATA do not always agree.

Some PMs express feelings that in their accountable role as weapon system manager, they have the overall right to establish depot support with whatever ATE they feel is best. Depot managers, on the other hand, feel that in their role as "business-like" managers of the installations, they have the right to select the equipment that is most cost-effective for the job. USATA feels that, as DA manager of all TMDE, calibration and repair support provider for all Army TMDE, and PM for IFTE, they have the right to pursue customers for the standard IFTE. The Army ATE Policy gives USATA the final say in depot ATE selection regardless of the desires of the other players.

It is unlikely that USATA would make a decision that renders a weapon system unsupportable. However, USATA does make decisions that deny the use or acquisition of ATE that PMs/MSCs or depots desire on occasion.

This denial of waiver requests is certainly within the authority of USATA. However, it undermines the ability of DESCOM to manage as a business. Further, it forces and commits the PMs to a course of action for which the PM will be held accountable.

Most of AR 750-43 is oriented to the field Army. Its original purpose was to reduce or eliminate proliferation of TMDE and ATE in the field. The Army standard ATE programs were intended to solve problems that emerged from increasing test equipment complexity and quantity on the battlefield. The first standard ATE, EQUATE, was developed because in the 1970s, several PMs had fielded major developmental items of ATE along with their weapon systems. The complexity of many weapon systems was increasing at such a high rate that if something wasn't done soon, the battlefield would have been filled with unacceptable quantities of different ATE items.

It was not only the field that saw a dramatic increase in the use of complex TMDE. Depot quantities and different models of ATE were also increasing at an alarming rate. This was exacerbated by the fact that early generation ATE was costly to procure and maintain, and difficult to support. As a result of this emerging trend, the Army ATE policy that was written for the field was extended to apply to the depots in order to provide some relief from the influx of different makes of ATE. Unfortunately, the depot needs were significantly different from those of the field and the regulation was not modified to account for these differences. The Army ATE Policy and regulations have been a constant problem for PMs and depots.

B. DEPOTS

1. Goals

Depots have a goal to stay open and not be subjected to closure under the ongoing efforts to downsize the industrial base.

2. Strategies

Throughout the entire timeframe of this study, depots have operated under either the Army Industrial Fund (AIF) or

the Defense Business Operations Fund (DBOF), both of which require the depots to operate as a business. In order for any "business-like" service organization to accomplish the goal of staying in business, it is necessary to be competitive, cost-effective and customer oriented.

DoD has been increasing its effort to make depots accountable for their actions and decisions. In 1982, then Secretary of Defense Frank Carlucci issued his "initiatives," one of which required all services' depots to operate under an "Industrial Fund." Under AIF, the work that depots performed was not directly funded but rather reimbursed from whatever customer needed to have the work performed. Depots were required to include all the costs of doing business in the price that they were charging to customers via their "rates." [Ref. 3]

The term "rate" refers to the cost per hour to perform work. Competitors, both public and private, are very concerned with how well their own rates compare to all others. The BRAC commission uses these rates as one of the major factors in their analysis. A difference of a few dollars per hour can make the difference between being closed and being given an increased workload.

In practice, not all costs were truly included in the charge to the customer under the AIF. Subsequent to 1982, the move had been toward increased accountability through more delegation of authority and more "business-like" operational procedures. At the present, under the DBOF, most, if not all, installation costs are passed on to the customer via the charge to perform work.

This charge needs to be as low as practical and the quality of the work needs to meet the standards set by the customer. If the work is not as the customer specifies or the charge is too high, the customer is supposed to be able to take the work somewhere else.

In practice, it is difficult to move workload from one DoD installation to another due to intense political pressure concerning any suggested shift of workload. However, in the long run, if an installation's costs remain consistently high, or the quality of the work remains substandard, the economics will cause that specific installation to be targeted for closure, if there is a need to close any installation.

The BRAC process was set up as a bi-partisan committee in order to circumvent the politics of choosing which installations to close. With the current intensity of DoD downsizing and efforts to reduce the support infrastructure, depot rates or their contribution to DoD rates are prime targets for analysis by the BRAC commission. This is one piece of quantified data that is very useful when debating the merits of specific installation closures.

Even though depots are accountable for their own costs and thus for their own futures, they are not entirely in control of many of the factors that are used to establish the rates. Depot management decisions certainly have a significant effect on depot rates, but there still are many areas where depots are not given the freedom to manage as a business as originally intended by DoD.

It is not the point of this thesis to examine all the areas where depots fail to operate as a business, but I will briefly state a few in order to demonstrate this point. Depots are required to maintain and support various functions for military "Quality of Life." This includes such things as military family housing and golf courses. These items are funded, at least in part, through the depot rates and cannot be discontinued even if the corporate management decides that doing so would be in the installations' best interests.

Another area where depots are not managed as a business is employee workforce sizing. Depots are supposed to be able to hire when the workload increases and have layoffs when it

decreases, just as the private sector would do. In practice, depot workforce sizes are governed by federal, local, state and agency laws and regulations that far exceed the controls placed on private industry. It is not uncommon for depots to have far too many people for the work they have to perform. Even though management recognizes the need for reductions, they are not easy to do. Depots do reduce the workforce, but only after all the correct approvals from various organizations. The opposite is also true at times. If the funded work exceeds the capabilities of the onboard strength, the depots should be able to hire as long as they have money for the payroll. In theory, this is the way it is supposed to work, but in practice, depot manpower is capped by other organizations and counted against agency totals.

Another area where depots are not managed as a business is in obtaining material to be used in the maintenance processes. Depots must obtain repair parts from the supply system if they are available within that system. These items must be purchased by the depot just as if they were bought from a private business. Often the availability is lacking, which causes a backlog of work-in-process that is both costly to the depots and displeasing to the depots' customers. In other instances, when the supply cost far exceeds that available from private industry suppliers, depots are not allowed to shop. Depots have lost several major workload competitions due to the high cost of repair parts from the supply system. Following is an example of one of these lost competitions.

RRAD was ordered to compete for workload that it had already been doing for years. This is similar to actions being implemented across all military depots. At RRAD, the M113 armored personnel carrier engine overhaul was a substantial percentage of RRAD's mission. When RRAD bid for the work, their bid had to include the purchase price of

replacement cylinder sleeves bought from the supply system. RRAD tried to submit a bid that innovatively utilized local machine shops to refurbish the existing sleeves, but was told that regulations required them to use the supply system. The private contractor that won the workload did so even though his hourly rates were higher. The single factor that made this possible was that the contractor was allowed to bid doing the job in any way that got the work accomplished. He did so by choosing to not use the supply system but rather by using local machine shops to refurbish the cylinder sleeves.

In several cases, such as RRAD's, depots protested that they could have been low bidder if they were allowed to obtain parts from the same sources as the winning private bidder. These regulatory built-in inequities in the system need to be corrected if depots are to become truly competitive with private industry, if that is DoD's strategy.

Another area where depots are not managed as a business is in the selection of support equipment such as ATE. The way that depots fund and budget for support equipment is not much different than private industry, whereas the way they select which item to buy differs greatly. The Army has regulations that govern many different types of equipment, such as industrial plant equipment, TMDE and ATE. The regulation that governs procurement of TMDE, including ATE is Army Regulation (AR) 750-43. AR 750-43, Chapter 4, ATE General Policy Requirements is at Appendix B.

When deciding to procure a major item of ATE, a competitively run company would most likely conduct a cost or economic analysis considering alternatives. After weighing all the foreseeable factors, a decision would be made to buy the best value ATE item for that company. In the Army depots, this is only true to a point. The depots do conduct economic analyses, but the alternatives considered are partially mandated by regulatory requirements, and the ultimate decision

of which ATE to procure is made by an organization completely outside the depot corporate management structure and outside the management structure of the customer to be supported by that ATE.

AR 750-43 requires the use of the Army general purpose standard ATE, which at the current time is the IFTE. If depots wish to use IFTE, they are permitted to go out and buy one or use one they already own if it has enough capacity. If depots wish to use any ATE other than IFTE, they must justify it to USATA. Justifications are allowable for three reasons, cost, schedule or performance.

Although the regulation allows for cost and performance justifications, in practice, USATA allows for schedule to be used as a justification in some cases. An example of a schedule driven waiver follows. When depot support is needed in a short timeframe, and there are already TPSs developed for the alternate ATE, as is often the case when there was Interim Contractor Logistics Support for depot maintenance, USATA will grant waivers.

Depots are in competition with each other and private companies for workload. As stated earlier in this thesis, private companies are not required to abide by the same regulations as the organic industrial base, and, in fact, this dichotomy is only likely to widen as the move toward contracting deregulation increases. For the case of Interim Contractor Logistics Support, this is the main reason why much of the costly to support, special purpose, one-of-a-kind test equipment often winds up in depots against both depots' and USATA's desires. Contractors are given short term maintenance work to perform and not told how to do it. They develop special purpose testers that eventually migrate to organic depots.

Cost justification is commonly used as a reason to acquire an item of ATE other than IFTE, but it is not a simple

matter to pursue. It requires an extensive analysis of all alternatives, including IFTE. However, it is usually the most important reason why a depot would choose any item of equipment. Depots need to be exerting constant effort to keep their costs down in order to attain their constantly challenged goal of staying open.

Prior to IFTE, the Army standard ATE was EQUATE. Depots have about 40 of these EQUATE testers that were infused into them as a result of prior ATE policy requiring their use to support weapon system maintenance. Most of these testers were procured because the policy at that time required use of EQUATE just like current regulation requires use of IFTE. After IFTE became the new standard ATE, the depots were no longer allowed to use the already owned EQUATEs to support new workload without a cost justification. More recently, USATA has said that it will not allow use of EQUATE under any but the most extenuating circumstances.

From a depot "business-like" approach, it may make sense to accomplish new workload on an existing tester without the need to make an additional investment. However, as controlled by the USATA, most requests to use EQUATE are denied. Whereas depots are trying to keep their costs down by using EQUATE or other ATE, USATA has goals to field more IFTEs, purge EQUATEs from the inventory, and to keep proliferation of ATE to a minimum.

These USATA goals and depot goals are potentially conflicting. Depots could be forced to make expenditures and investments that they do not feel are in their best interests. Even in the event that the depots are making foolish decisions, this goes against the apparent intent of DoD to have the depots be accountable and manage "like a business," thus flourishing or dying by their own hand.

Depots are not only required to pay for the equipment that is acquired in support of their mission, they are also

required to capitalize that equipment in their rates in order to be able to maintain, repair and replace it as it ages and wears out, very much like any business. Due to this capitalization or depreciation, depots may prefer to purchase new low cost COTS ATE rather than being given already owned, special purpose expensive ATE. The same logic holds true for IFTE.

C. U.S. ARMY TMDE ACTIVITY

1. Goals

USATA has a goal to manage Army wide use of TMDE and ATE by limiting proliferation of different makes and models. USATA, via the mission of USATSG, has the goal to maintain a high readiness rate by calibrating and repairing all Army TMDE. USATA, via the mission of the PM-TMDE, has the goal to promote standardization of ATE and to maximize the number of standard ATE that is fielded.

2. Strategies

One of the big problems in the field is proliferation of TMDE, including ATE. AR 750-43 was written to control that proliferation. Proliferation causes calibration and repair support of the test equipment to be much more difficult. Each additional item of TMDE requires the fielding of manuals, spare parts, calibration standards, and providing training to the maintainers and operators.

This problem is exacerbated for automatic TMDE due to its increased complexity and cost over manual TMDE. ATE introduced to the field creates many more problems than manual TMDE because of the large dollar investment costs, increased difficulty to operate and maintain, physically larger size to transport, TPS maintenance costs and technical complexity. However, in the depots, the magnitude of these problems is considerably lessened by the fact that depots are at a fixed location, without the size and weight restrictions imposed on

field equipment, and within easy reach of the support of private industry. Further, depots have many very technologically advanced personnel who can assist in resolving any problems that might arise with the ATE. However, depots are not allowed to provide all the ATE support for themselves.

USATA functions to provide world-wide calibration and repair support for Army TMDE. This was not always the case. A regulatory change put the USATSG of USATA in charge of calibration and repair support of the depots. Depots are required to reimburse USATA for the support provided, even though use of USATSG is mandatory. This is considered to be "business-like" because it involves a reimbursement. Even if depots desire to provide their own support or to contract for it, they must first gain the approval of USATA on an individual item basis. Prior to this change, depots performed the calibration and repair support of their own equipment and thus proliferation of equipment was not an issue with USATSG. If proliferation of equipment in a depot became a support problem, it was totally of the depot's own making and resolution. Now that depots are required to rely on USATSG to support the TMDE and ATE that they acquire, USATA has additional justification and need to control the TMDE and ATE that goes into the depots. Before approving waivers, USATA needs to consider the impact of alternate ATE on the ability of USATSG to calibrate and support it. Otherwise, the goal of providing world-wide calibration and repair support might be jeopardized or made more difficult.

The PM-TMDE of USATA is responsible for developing, managing, and fielding standard ATE. The IFTE is the standard ATE that is currently being fielded to all Army users. As stated in previous chapters, it is advantageous to spread the development, management, and other costs among large numbers of customers. This brings down the unit costs of the IFTE, provides a larger logistics base, and makes the IFTE program

more successful. However, putting the same organization in charge of controlling waivers from using IFTE as the organization that has a goal to promote its sales might be considered a conflict of interest.

The PM-TMDE is the technical organization within USATA that reviews the depots waiver requests to deviate from use of the standard ATE. It is in the PM-TMDE's best interests to deny approval of alternate ATE if it is technically feasible for the standard to perform the required functions. This is in conflict with depot cost cutting goals.

D. PROGRAM MANAGERS/MAJOR SUBORDINATE COMMANDS

1. Goals

Program Managers (PMs), with the support of the Major Subordinate Commands (MSCs), have the goal of fielding a fully supportable weapon system that meets the users' requirements within established cost and schedule constraints.

2. Strategies

Program Managers are the single points of contact for their weapon systems. They are accountable for accomplishing their goals by managing the entire program. PMs provide the centralized authority and responsibility for accomplishment of the weapon system program goals. They do so by integrating all the specialties into a coherent, coordinated management structure.

Major Subordinate Commands provide the matrix support to the PMs for accomplishment of many of the tasks necessary to successfully accomplish the goals. For the sake of establishing depot-level support of weapon systems, it is both the PM and the MSC that are involved. For this reason, the term PM/MSC will usually be used when referring to the PMs' interests. It would unnecessarily complicate the issue to attempt to distinguish between these two entities except when there is a distinct reason to do so.

PMs have all aspects of the program to manage, including maintenance support. Depot-level support is frequently accomplished through temporary use of the production contractor before transitioning to an organic Army depot or the permanent contractor depot. This support is referred to as Interim Contractor Logistics Support.

Depot-level maintenance is not the most pressing concern for most PMs/MSCs. Planning for it comes at a time when fielding dates are in the forefront of concerns. Before the weapon system can be type classified "standard" and move into production, field maintenance must be **demonstrated**. However, depot maintenance need only be **addressed**. This is commonly done by stating that depot-level maintenance will be done as Interim Contractor Logistics Support with a follow-on transition to organic at a date "to-be-determined." [Ref. 19]

In order to meet the PM's fielding milestones, it is a necessity to not require a PM/MSC to demonstrate depot-level maintenance before fielding a weapon system. If it were required that he or she must demonstrate depot maintenance, fieldings would often be considerably delayed while all the complicated equipment and tests were being developed. Besides, most systems need to be fielded and operated for a while before they need depot maintenance.

Even when a detailed Logistics Support Analysis (LSA) is conducted, it doesn't produce data to tell how to conduct the depot testing, but rather it may state that TMDE, ATE or throwaway of a component is required. In practice, the LSA doesn't provide much support in designing depot tests.

The PMs/MSCs usually rely on the production contractor to tell them how to perform depot-level diagnostic testing. If the system was very well managed, testing would have been addressed throughout the design process through the use of concurrent engineering. However, this is seldom the case. Rather, when the PMs/MSCs negotiate the support contract, they

usually allow the contractor to use whatever means available to perform testing.

Attempts have been made to require the support contractor to use the Army standard ATE, but most of these attempts were stopped by the Government contracting offices as being overly restrictive in telling the contractor how to perform the mission rather than stating what needs to be done. As a result, the support contractor, who is usually the same as the production contractor, usually adapts the same test equipment that was used in production. As stated previously, this test equipment is usually sub-optimal for diagnostic purposes, but it may suffice for the short interim maintenance contract. This is especially true when the design and production engineers are available to assist in the maintenance process.

The problems arise when the time comes to transition to an organic depot. If the Government already owns this often one-of-a-kind special purpose test equipment, it is difficult to justify an immediate expense to procure replacement equipment that is more suitable for long term depot-level maintenance work. If the Government does not already own the equipment, the contractors who no longer have a need for it usually offer it for whatever price they feel the market will bear. The offered price is often tempered by the fact that this capability is available immediately, whereas a complicated test system that requires use of ATE and many TPSs might be years away if development hasn't yet started.

PMs/MSCs need to budget for and reimburse depots for the maintenance work. They try to get the most value for their dollars. The rate that the depot charges is dependent on how efficiently the support equipment performs and how much the whole set of support equipment costs to procure and maintain, as all this is included in the depot rates. Both parties, depots and PMs/MSCs have similar goals in mind. However, they

are sometimes at odds over what is the best test solution to achieve their goals.

DESCOM aspires to do whatever is best for their goal of having depots stay open. PMs/MSCs aspire to do what is best for the weapon systems. Ultimately, it is the PM who is accountable for how well his weapon system performs, including maintenance. With depots being accountable for how well they meet their customers' requirements, depots should be performing as the PMs desire. This is usually the case, but differences in desired test methodology do arise.

E. TECHNICAL ANALYSIS

As explained in the sections on missions and functions, depots and MSCs are commodity-oriented. In practice, even though many of the different commodities need complex ATE to resolve the maintenance failures, the nature of the testers often precludes across-the-board standardization. These differences are readily observed when visiting the depots or when reviewing the technical data in the correspondence files for ATE waiver requests. This section characterizes the major categories that should obtain special treatment in the planning for testability and the processing of waivers. It is important to note that standardization within a category is possible but across categories is not. [Ref. 3, 20]

1. Mechanical Testing

AMCCOM and TACOM systems overhauled at ANAD, LEAD, and RRAD require extensive use of automated dynamometers and test stands in order to test the engines and transmissions. ATCOM rotary-wing aircraft require similar automated testers. The dynamometers measure parameters such as engine's shaft horsepower and torque. Transmissions and differentials require automated test stands to measure output and operational performance, and analyze internal hydraulic pressures, temperatures and various mechanical activities.

The Army standard ATE has no provisions to perform such physical measurements. Nonetheless, USATA, operating within the letter of the ATE policy required extensive justification before waiving use of the standard ATE. Following is one example of a typical action.

The AGT 1500 turbine engine in the M1 tank is a highly complex piece of machinery. Automated testers that can test this kind of mechanical device are highly specialized and available from a unique component of commercial industry. Testing requires placing numerous sensors to measure temperature, flow rates, pressure, speeds and other parameters pertaining to the systems being tested, and to correlate these measurements within a main computer that is also responsible for conducting the test. Also included in the turbine engine test are delicate measurements of asynchronous vibration that can help detect latent failures in many of the high-speed critical parts.

Even though the EQUATE, the standard ATE at the time, was obviously not capable of measuring any of these parameters, the waiver justification required by USATA had to include a detailed analysis to determine what it would take to augment EQUATE to perform such tests. As it turned out, the EQUATE computer could have been used to control some of the equipment in the desired tester, but development costs would have been enormous compared to the COTS testers. After extensive justification, the waiver was approved. This is a typical example of the kind of ATE that is associated with mechanical work and the waiver process that is associated with it.

2. Wiring Harnesses

All commodities have wiring harnesses within their systems that need to be tested and repaired. The AMCCOM armament, TACOM vehicles, ATCOM aircraft and troop support electronics items, CECOM communication and electronic shelters and MICOM missile systems all have wiring harnesses connecting

the black boxes. Wiring harnesses need to be tested for continuity, shorts, proper connections, and other parameters. Slip rings on turrets also need to be tested for similar parameters. There are a few companies that specialize in testers that automatically perform all the tests necessary for cable and harness testing.

HQDESCOM competitively awarded a five year requirements contract to DITMCO, one of the leading vendors of these COTS testers. In the early timeframe for this study, it took extensive justification to procure cable harness testers in lieu of the standard ATE even though the standard ATE could not test cables and harnesses without extensive augmentation. Now that there is a DESCOM standard, it is easier to get waivers; however waivers are still required. HQDESCOM and the PMs/MSCs would prefer to have blanket waiver to buy these testers since they cost less than one-third the cost of IFTE and perform tests that IFTE cannot easily do. However, USATA still requires waivers on a case by case basis, but grants them reasonably quickly. The waiver files for the DITMCO shows that all depots have procured items from this contract.

3. Electronics

ANAD also tests AMCCOM electronic components. The electronics in Army tanks are quite sophisticated. Some of the early generation ATE that is used to test the M60 tank are special purpose ATE designed just for this one purpose. At the time they were developed, there were not many alternatives available in either the industry or the Government that were capable of such sophistication. However, now there are many such items of ATE available in the commercial marketplace. These old items still exist in the depots, but there are plans to convert to more modern and supportable ATE. Unfortunately,these conversions will be in competition with IFTE via the waiver process.

TOAD and SAAD are, for the most part, very similar to each other but completely different from other depots in their compliment of ATE used to test CECOM and some ATCOM electronic items. These depots prefer to use COTS ATE. Nonetheless, they each have many EQUATEs and IFTEs and are quite capable at operating and repairing them. TOAD is the depot that is assigned to do depot-level maintenance and repair on the EQUATEs and IFTEs that are fielded. Further, TOAD and SAAD have large TPS development capabilities and "repositories." Repositories are areas where TPSs are developed, stored, configuration managed and manufactured.

Both of these depots requested waivers to use existing, previous generation ATE, the EQUATE, to perform new maintenance workload. They justified the requests by the fact that no new expenditures would be necessary for ATE hardware. Initially, some of these waivers were approved, but recently, all waivers have been denied. USATA wants depots to move on to IFTE regardless of cost.

If given the choice, these depots would almost always choose to use COTS ATE for their testing needs. There have been numerous waivers requested and granted for COTS ATE at these depots.

4. Electro-Optics

Fire control items for AMCCOM and MICOM systems were tested mostly at ANAD and SAAD. Some of the fire control systems are assembled at other depots, but the black boxes were sent to SAAD or ANAD for complete disassembly and repair. Some of the complex fire control items use large, very expensive, special purpose optics-benches built by the original missile manufacturers. These complex benches sometimes require the assistance of on-site contractors' representatives who, in some cases, are full-time.

The automated versions of these benches required waivers from the ATE policy even though the standard ATE at the time

did not test optics. Integral with optics is electronics and the associated tests, which are often done with test equipment built into the automatic optics-benches.

This integral electronics has often been an area of contention for the granting of waivers. USATA would like to see the electronics broken out of the overall test and assigned to the Army standard ATE. However, many of these electro-optics testers were developed by the PM/MSC working through the contractor without any regard for policy until time came to transition to depots. The ATE was often developed for contractor use before being transferred to depots. Nonetheless, waivers had to be acquired before the equipment could be transferred to organic depots. Surprisingly, some of these waivers took the most effort of any waivers in the way of correspondence, business travel and meetings to justify. Perhaps it is due to these items having by far the largest associated costs and difficulty to support.

USATA is working to establish a standard electro-optics test capability. It is unknown at this time whether this capability will provide useful cost-effective standardization. However, it appears logical to move away from the myriad of very expensive electro-optics ATE currently in existence. This is an area with much potential for cost savings if technology provides the answers.

V. CONCLUSIONS AND RECOMMENDATIONS

The effectiveness of management practices, policies, and regulations that affect acquisition of ATE for depot-level testing of weapon systems in organic Army depots is less than desirable. In practice, the actual selection of ATE is the result of a mix of different organizational goals and strategies from each of three players, PMs, depots and USATA. Each ATE waiver that was studied as part of this thesis consisted of extensive amounts of paperwork representing many hours spent by the requesting parties.

This thesis recommends excluding depot ATE from the controls of AR 750-43 and the Army ATE Policy. The Army ATE policies and regulations are field Army oriented to control proliferation and promote standardization of functional, developmental ATE. By controlling depot ATE acquisitions, this AR eliminates the abilities of the depots to be managed as "businesses" as intended by DoD. Regulations and policies, such as the Army ATE Policy and AR 750-43 preclude the depots from making decisions that affect their own future. These controls cause additional costs to accrue that add to the depots' rates and make the depots less competitive. Besides, even if depots were to make bad decisions, they should be allowed to do so, and as a result, go out of business. Depots are accountable for their actions just like their commercial counterparts.

PMs should hold depots accountable and should have the final say in judging how **well** the depots perform their mission, but only under extenuating circumstances should PMs be able to control **how** depots choose to perform their work.

Conflicting organizational goals and strategies come into play whenever there is a requirement for depot ATE selection. The players did not act in concert and the mixed results reviewed in the ATE waivers reflect this situation. Because there are multiple organizations with differing goals, it

would be subjective to conclude that any of the selections were or were not effective without examining them from the perspective of each player. Often, an ATE selection that is considered correct by one player undermines the goals of the other players.

This is especially true when considering USATA. USATA is not a stakeholder in either the depots' or PMs' successes, although they certainly would not want to be the cause of a mission failure. Often, though not always, the PM's and depot's preferred solutions agreed with the other, but differed from USATA's solution. USATA's solution, by default, was always the Army developed standard ATE. It is in USATA's best interests to promote increased use of the standard ATE, and as such their actions are always biased. USATA, as an organization, has much experience with ATE technical matters, calibration and repair support. They can provide valuable assistance to depots and PMs, and should be available for consultation when depots or PMs are making ATE selection decisions. However, their actions should be considered recommendations, not binding decisions.

PMs were often influenced by the production contractor's insistence that it is in the weapon system's best interests to procure special purpose ATE designed by that contractor. Depots usually chose to utilize the most cost-effective ATE, and PMs usually agreed with the depot choice unless there was either a time constraint or a contractor recommended solution, or both. In many cases, expensive, difficult to maintain, special purpose ATE did get placed into the organic depots. Both PMs and depots should consider the required schedule for organic maintenance, review all technical alternatives, and work together to avoid special purpose ATE if possible.

Similar to buying the contractors recommended special purpose ATE, Program Managers often "selected" depot ATE by default through establishing Interim Contractor Logistics

Support with the weapon system production contractors. These contractors frequently modified the existing production "functional" ATE to perform diagnostics, which was a less than optimal way to do the required testing. Further, many of these items of ATE were special purpose, developmental ATE that have high life cycle costs and are difficult to support, thus contributing to higher depot rates, which neither the depots nor the PMs want. Nonetheless, these items frequently transitioned to organic Army depots due to the fact that the costs are sunk and the testers already exist. Organic depots typically have little say over initial development of ATE capability that occurs this way. PMs should be aware of the potential effects of special purpose developmental ATE when they are confronted with establishing depot-level diagnostic capability. If possible, special purpose developmental ATE should be avoided.

Despite the need to operate cost-effectively, depots did not always select the most cost-effective ATE. Their decisions were sometimes biased by experiential knowledge of existing ATE that they already had in their shops, even if that ATE was already nearly obsolete. These items were probably not be the best choice for the job given the circumstances. If a weapon system fielding schedule requires a depot test solution in a short timeframe, use of near-obsolete, familiar, existing ATE may be the only choice. However, this should be avoided if at all possible in the same way that contractor developed special purpose ATE should be avoided.

Most of the depots' selections of COTS ATE appeared to be cost-effective in the waiver requests. The vast majority of ATE waivers that were requested to utilize COTS ATE were granted by USATA because they were proven to be the least costly alternative. In some cases where COTS ATE waivers were not granted, USATA had valid concerns that depots were buying

multiple makes and models of nearly identical testers, thus not taking advantage of economies of scale for price, logistics, or experience. This observation does not support having USATA **control** depot ATE acquisitions, but rather that depots should pay more attention to standardization and that USATA could add value as a consultant. The standard "family" of depot ATE and associated multi-year requirements contracts that depots are using are a step in the right direction and should be expanded. Several of the PEOs had positive reactions toward the depot standard family ATE concept.

Lastly, all depots have some unique, commodity-oriented testing requirements. At some depots, these commodity-oriented test requirements are predominant over the more conventional electronics testing that the Army standard performs. Many of the waivers reviewed in this study were for testers to perform measurements that the Army standard ATE cannot perform without extensive augmentation. Some of these testers are only available as special purpose developmental models while others have COTS availability. There are several recommendations to be made. If depots are not exempted from AR 750-43 as previously recommended in this thesis, then special provisions should be added to the regulation to exempt these special purpose, unique test requirements from the often laborious waiver procedures. Depots should attempt to utilize COTS ATE whenever practical for testing these commodity-oriented items. In both cases of developmental and COTS ATE, efforts should be made to standardize and take advantage of the economies of scale.

APPENDIX A. ABBREVIATIONS AND ACRONYMS

AIF	Army Industrial Fund
AMC	Army Materiel Command
AMCCOM	Armament, Munitions, and Chemical Command
ANAD	Anniston Army Depot
AR	Army Regulation
ATCOM	Aviation and Troop Support Command
ATE	Automatic Test Equipment
ATS	Automatic Test Systems
BRAC	Base Realignment and Closure
CASS	Consolidated Automated Support System
CCAD	Corpus Christi Army Depot
CECOM	Communications and Electronics Command
CG	Commanding General
COTS	Commercial Off-The-Shelf
DA	Department of Army
DBOF	Defense Business Operations Fund
DEDT	Deputy Executive Director for TMDE
DESCOM	Depot Systems Command
DoD	Department of Defense
EQUATE	Electronics Quality Assurance Test Equipment
HQDESCOM	Headquarters, U.S. Army Depot System Command
ICD	Interconnect Device
IDA	Institute for Defense Analysis
IFTE	Integrated Family of Test Equipment
IOC	Industrial Operations Command
LEAD	Letterkenny Army Depot
LRU	Line Replacement Unit
MZAD	Mainz Army Depot Complex
MICOM	Missile Command
MSC	Major Subordinate Command
NDI	Non-developmental Item
PCB	Printed Circuit Board
PEO	Program Executive Officer

PM	Program Manager
RRAD	Red River Army Depot
SAAD	Sacramento Army Depot
TACOM	Tank-Automotive and Armaments Command
TEAD	Tooele Army Depot
TMDE	Test, Measurement, and Diagnostic Equipment
TOAD	Tobyhanna Army Depot
TPS	Test Program Set
USATA	United States Army TMDE Activity
USATSG	United States Army TMDE Support Group
UUT	Unit Under Test

Headquarters
Department of the Army
Washington, DC
29 September 1989

***Army Regulation 750–43**

Effective 27 October 1989

Maintenance of Supplies and Equipment

Army Test, Measurement, and Diagnostic Equipment Program

This UPDATE publishes a revision of this publication. Because the publication has been extensively revised, the changed portions have not been highlighted.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

MILTON H. HAMILTON
Administrative Assistant to the Secretary of the Army

Summary. This regulation governs the Army Test, Measurement and Diagnostic Equipment Program. It establishes policies, assigns responsibilities, and provides instructions. Specifically, this regulation prescribes general TMDE management, the TMDE Calibration and Repair Support (C&RS) Program, automatic test equipment (ATE) hardware and software policies, and TMDE acquisition and standardization procedures.

Applicability. This regulation applies to the Active Army, the Army National Guard, and the U.S. Army Reserve. Specifically, it applies to all U.S. Army elements that select, acquire, supply, or use TMDE to support Army missions.

Internal control systems. This regulation is subject to the requirements of AR 11-2. It contains internal control provisions but does not contain checklists for conducting internal reviews. These checklists are being developed and will be published at a later date.

Supplementation. Supplementation of this regulation and establishment of forms other than DA forms are prohibited without prior approval from HQDA (DALO–SMC), WASH DC 20310–0542.

Interim changes. Interim changes to this regulation are not official unless they are authenticated by the Administrative Assistant to the Secretary of the Army. Users will destroy interim changes on their expiration dates unless sooner superseded or rescinded.

Suggested improvements. The proponent agency of this regulation is the Office of Deputy Chief of Staff for Logistics. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to Commander, U.S. Army Materiel Command, ATTN: AMCTM, 5001 Eisenhower Avenue, Alexandria, VA 22333–0001.

Distribution. This publication has been distributed as required on DA Form 12–09–E, Block 3864, intended for command level B for the Active Army, ARNG, and USAR.

Contents (Listed by paragraph number)

*This regulation supersedes AR 750–25, 1 September 1983, and AR 750–43, 1 March 1984.

Chapter 4
ATE and TPS Policy

Section I
ATE General Policy Requirements

4-1. General ATE policy
All ATE procured by the Army for use in the field, depot, or in the system developer's production facility must be acquired in accordance with this regulation and current DA Army policy directives.

4-2. Determination of ATE requirements
a. Nonstandard ATE will not be used in lieu of designated standard ATE without an appropriate economic analysis using the designated standard ATE as the baseline alternative.

b. Contractors who have a requirement for automatic TPS development/validation or special acceptance and inspection equipment (SAIE) are required to document those requirements in terms of—

(1) Productivity.

(2) Technical testability constraints.

(3) Economics related to producibility, product quality, etc.

c. System developers in coordination with PM-TMDE, USACTA, and TRADOC (AMC Depot System Command (DESCOM) for production/depot ATE) will determine their ATE requirements. A system repair level analysis (RLA) will be performed per MIL-STD-1388/1A (LSA) and in conjunction with MIL-STD-2165 (testability program). The system RLA will identify as well as justify ATE requirements at the various levels of maintenance.

d. The PM-TMDE and USACTA will assist system developers in the preparation of the system RLA which will address the following areas:

(1) BIT/BITE requirements.

(2) TMDE requirements and alternatives, system test envelope, workload distribution, and estimated failure frequency.

(3) System maintenance plan and personnel requirements.

(4) System interface and TPS requirements.

(5) Force structure requirements.

(6) Life cycle costs.

(7) Risk assessment.

e. Once the ATE requirements have been identified for a system, the system developer (in conjunction with USACTA, PM-TMDE, and TRADOC (for field ATE) or DESCOM (for production/depot ATE)), will—

(1) Determine if the use of designated standard ATE will fulfill the ATE technical and operational requirements of the system.

(2) If the ATE requirements are not satisfied the system developer will determine the feasibility of expanding the basic capabilities of the designed standard ATE.

(3) If neither is feasible, submit a waiver request in accordance with paragraph 4-3.

4-3. ATE waiver procedures
On determination that ATE is required and the designated standard ATE hardware/software cannot be used or expanded in capability or is not cost effective to accommodate the test requirements, the following procedures will be followed:

a. The developer or requiring activity will determine the basis for a waiver and will identify alternate candidate ATE systems based on the priorities established in paragraph 4-4.

b. The developer or requiring activity will submit a formal waiver request, with TRADOC/DESCOM endorsement, as appropriate, to USACTA with a copy to PM-TMDE. Each waiver request will include completed copies of DA Forms 4062-R and 4062-1-R (according to chap 3, sec III), as applicable, and schematic drawings/block diagrams which depict the proposed ATE alternative.

c. On receipt of the formal waiver request, USACTA will confirm the basis for waiver request, and coordinate the request with other agencies as necessary (e.g., USATSG, DESCOM, TRADOC or appropriate program/project managers) to establish waiver validity. The PM-TMDE will technically evaluate the waiver request.

(1) If the waiver request is endorsed, USACTA will forward the waiver request will acceptance/recommendation and PM-TMDE technical evaluation/recommendation to the DEDT. The DEDT will either approve the waiver request or advise the requesting activity to clarify specific issues before providing a final decision.

(2) If the waiver request is not endorsed, USACTA will provide nonconcurrence, with the rationale, to the requesting activity (copy furnished to the DEDT). The requesting activity may submit an updated waiver request to the USACTA to resolve the basis for the previous nonconcurrences. Table 4-1 explains ATE waiver documentation. Figure 4-1 illustrates the ATE selection and waiver process.

Table 4-1
Automatic test equipment waiver documentation

General

DA/HQ AMC direction/basis for waiver: HQDA or HQ AMC policy decisions or directives preclude use of the designated ATE standard.
Documentation required: A copy of the decision or directive precluding use of the designated ATE standard.

Technical

DA/HQ AMC direction/basis for waiver: Use of the designated ATE standard to meet supported weapon system ATE requirements is not technically feasible without obviously uneconomical major modifications. Use of the designated ATE standard would impose unrealistic program and/or technical obstacles.
Documentation required: Documentation that lists the system test requirements in a side-by-side comparison with designated standard ATE capabilities and the proposed alternative that demonstrates conclusively that the designated standard ATE is unfeasible. Unmatched requirements to capabilities will include engineering analysis estimates to the extent of the modification required to the designated ATE standard to force compatibility. To qualify for technical exclusion, the comparison and analysis must unambiguously show that the standard ATE is not a viable alternative (otherwise an economic analysis is required).

Cost

DA/HQ AMC direction/basis for waiver: Use of the designated standard is clearly not the most cost effective ATE alternative for the Army.
Documentation required: A copy cost/economic analysis reflecting use of the designated ATE standard versus use of the proposed ATE alternative. The analysis will be prepared according to AR 11-28 and DA Pams 11-2 through 5 and validated by the local comptroller. Critical cost differences will be highlighted and discussed in detail. The analysis will show that use of designated ATE standard is not cost effective for the Army. The analysis will be supported by the following:

a. An assessment of the LSA (or a copy of the LSAR) that substantiates use of ATE in the materiel system maintenance concept. This assessment will address the tradeoff among ATE, contractor support, and other test capability (including throwaway) with respect to the specific supported end item LRUs and printed circuit boards.

b. An assessment of operational and readiness benefits to be derived if the proposed ATE alternative is approved. This assessment will also address whether the proposed ATE alternative can perform ATE workloads of other type end items in lieu of the designated ATE standard.

c. Direct consideration of acquisition, operation, and support costs; TPS costs; deployment constraints; ATE workload requirements; and asset availability. When considering asset availability, the analysis will address the capability of existing and programmed designated ATE standard assets to accomplish the workload requirement through shared utilization as based on prorated costs.

Nonstandard augmentation required

DA/HQ AMC direction/basis for waiver: Use of system peculiar ATE with the designated ATE standard is necessary to reduce the workload of the designated ATE standard.

Documentation required: A copy of a cost/economic analysis reflecting use of existing, programmed, and additional designated ATE standard assets versus use of existing and programmed designated ATE standard assets with system peculiar ATE. The analysis will be consistent with provisions of the cost waiver and subparagraphs thereof.

4-4. ATE selection procedures

The USACTA will maintain in the TEMIS a list of all Army ATE and will develop and maintain an ATE priority list to assist the materiel developers to select appropriate ATE. The precedence for ATE selection is as follows:

a. ATE priority list.

(1) AMC or DA designated standard ATE (including other services' ATE).

(2) PIL/PIL candidate.

(3) Other priority ATE.

b. Registered items or commercial items (nondevelopmental).

c. New development special purpose item.

4-5. ATE system software

a. The proponent ATE materiel manager will manage software embedded in the specific TMDE consistent with Army policy. The materiel manager will decide how this software will be accessed, modified, or maintained. Changes to general purpose ATE system software will be coordinated with the—

(1) USACTA and PM-TMDE.

(2) Command having equipment supported by the subject ATE.

(3) Combat developer for the equipment supported.

b. ATE system software developed for and issued with a particular ATE is considered to be part of that ATE. ATE system software and related software products will be—

(1) Written in a DOD-approved higher order language (HOL) or language subset.

(2) Planned, acquired, verified, and deployed in agreement with TMDE acquisition strategy. It will be a specified variable in design and logistic tradeoff analyses.

(3) Documented consistent with established criteria to the extent that fielded software can be used without contractor support. Necessary ATE software support items will be specified as contractually deliverable with unlimited rights for DOD use.

(4) Separate contract line items where practical.

c. ATE system software development will be equally emphasized with ATE hardware development. Consideration will be given to software modularity, ease-of-change, and transferability.

d. ATE system software design, programming, maintenance, and configuration management will have a disciplined approach that provides effective ATE software at minimum life cycle cost.

e. ATE system software change or update will be tested and verified before field release.

f. Waivers from the use of an approved DOD high order language may be granted only on a specific system or subsystem basis. The costs and risks associated with language proliferation must be weighed against the waiver benefits accruing to the intended subsystem.

(1) A justification analysis, developed by the materiel developer in coordination with the combat developer, will be submitted through USACTA to the DEDT for approval.

(2) When a waiver is granted, a summary analysis will be forwarded to the Defense Computer Resources Board in accordance with DODD 3405.1.

4-6. ATE interface

The supported end item will have integrated into the design necessary diagnostic connector assemblies and data buses which provide the minimum number of test connection points necessary to satisfy end item testability constraints. The design objective will be to minimize the development of TPS interconnection devices and cables necessary to [illegible]

Section II
ATE Selection criteria for Joint Programs

4-7. Criteria for selection of ATE for joint programs

Each service has its own unique ATE standardization policies necessitated by basic mission differences and operational scenarios. In order to minimize duplicate costs on joint programs for technical publications, training, test program sets and other logistics factors, the following guidelines will be used on joint programs:

a. BIT and BITE will be used in the design of the system to minimize reliance on off-line ATE, especially at organizational and DS/GS levels.

b. Depot level maintenance technical publications, training, TPS, and other logistics items will be procured only for the service depots designated to perform depot level maintenance for the joint system. Designation of the performing depots will be required early in the acquisition cycle.

4-8. Redistribution of underutilized ATE

Managers of fielded ATE will identify any underutilized ATE to the Program Manager, Test, Measurement, and Diagnostic Equipment, Attn: AMCPM-TMDE, Fort Monmouth, NJ 07703-5000, for evaluation. The PM-TMDE will recommend to the DEDT the disposition of the underutilized ATE. The DEDT will negotiate the redistribution of the underutilized ATE with the appropriate MACOM.

Section III
TPS Management

4-9. TPS management (general)

a. TPS management encompasses the life cycle administrative and technical management of TPSs used with DS/GS, depot, and the system's developer (contractor) ATE. The TPS life cycle management will be a separate and distinct action in the system's life cycle, consistent with DOD, Army, and AMC embedded computer resources guidelines.

b. Configuration management according to AR 70-37 and procedures established by the DEDT, through designated agent PM-TPS, will identify, control, account for, and audit the functional and physical characteristics of the TPS. Each TPS will undergo both a functional configuration audit (FCA) and a physical configuration audit (PCA).

c. The central document for monitoring and controlling TPS development, acquisition, and maintenance throughout the system life cycle is the TPS management plan (TPSMP).

(1) The TPSMP will be a living document tailored to the individual system development and acquisition strategy.

(2) System acquisition will not proceed into the full scale engineering development (FSED) phase until the TPSMP has been reviewed and approved by PM-TPS or a waiver has been processed through the DEDT. The TPSMP will be used to support other formal planning documents and will be included as part of the ILSP.

(3) The TPS materiel manager is responsible for ensuring the development of the TPSMP.

(4) The TPS center of the supporting materiel command will act as the principal staff adviser to the TPS materiel manager, and will actively assist in the TPSMP development.

4-10. TPS responsibilities and procedures

a. The PM-TMDE, under the direction of the DEDT, will establish and maintain a PM-TPS office to ensure compliance with TPS policy and procedures by—

(1) Monitoring the TPS Center's implementation plans and resource impact statements for TPS support. Once the TPS Center's implementation plan is satisfactorily established, the plan need not be maintained.

(2) Approving each materiel developer's TPSMP.

(4) Approving all waiver requests for nonstandard TPS development programs.

(5) Monitoring and coordinating the level of in-house TPS development support.

(6) Ensuring that TPS planning, development, acquisition, fielding, and life cycle support are consistent throughout the Army.

(7) Registering TPSs according to the procedures established by the DEDT.

(8) Establishing and maintaining a TPS database for monitoring TPS status, TPS availability, parts commonality, and unit under test (UUT) application. TPS/ATE/TMDE information will be coordinated with USACTA to ensure data integrity.

(9) Developing and maintaining an Army TPS education program.

b. All materiel commands with TPS development requirements will—

(1) Prepare a TPS implementation plan and forward a copy to the PM–TPS.

(2) Prepare a resource impact statement outlining all source requirements and impacts associated with the TPS implementation plan and forward it to the PM–TMDE. Send information copies to Commander, U.S. Army Central TMDE Activity, Attn: AMXCT, Lexington, KY 40511-5104 and Commander, U.S. Army Materiel Command, Attn: AMCTM–E, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001.

(3) Maintain capacity for development, maintenance and support of managed TPSs.

(4) Establish and maintain TPS Centers for management of TPS development, acquisition, fielding, requisition, and support. The TPS Centers will provide TPS technical and management support to materiel developers/managers.

c. The TPS Center Commander will—

(1) Assist in the preparation of the draft TPSMP and all updates/revisions to the TPSMP for the materiel developer.

(2) Be the principal reviewer agency prior to submission to PM–TPS. Nonconcurrence with any part of the TPSMP must be coordinated with the materiel developer to resolve conflicts prior to submission to PM–TPS.

(3) Receive and review the TPS cost and schedule reports periodically submitted by the TPS developer.

(4) Coordinate, consolidate, and submit TPS data to the TPS database developed and managed by PM–TPS. This will be a recurring requirement.

d. The weapon system program manager and materiel developer will—

(1) Establish a memorandum of understanding with the supporting command for the purpose of identifying principal TPS Center support.

(2) Prepare a TPSMP for each system that will, or is expected to, require automatic testing.

(3) Coordinate TPS development and fielding actions with the supporting TPS Center and the PM–TPS.

(4) Acquire TPS support for the supported system according to the requirements outlined in this chapter.

e. AMC (DESCOM) will establish an office to maintain an Army organic TPS acquisition support capability, and provide TPS development services or TPS postdeployment support, or both, for systems when contracted by the commands.

(1) Depots will continue to provide related TPS acquisition support such as being members of source selection evaluation boards (SSEBs), supporting development of ATE hardware and system software augmentation. Depots will also provide expertise to materiel developers in acquiring and developing ATE vans and shelters.

(2) TPS will be required and fielded consistent with security provisions of AR 380-5, AR 530-4, and TB 380-41-series. Classified information handled by automatic TMDE will be protected as prescribed in AR 380-380.

(3) Classified TPSs will not be released to the field unless a validated requirement exists and regulatory security provisions have been satisfied by the automatic TMDE user.

4-11. TPS management plan (TPSMP) development

The TPSMP will be prepared as outlined in section IV.

a. Accelerated development programs that omit any intervening milestones between concept and the production decision require an approved TPSMP as soon as the necessary information is known.

b. In general, systems will not pass into FSED or its equivalent, or have a request for proposal (RFP) issued without a TPSMP approved by the PM–TPS.

4-12. Prime system life cycle criteria

The following TPS related criteria will be met at the associated milestone in the prime system life cycle.

a. Milestone I to Milestone II—Demonstration and validation phase—

(1) TPSMP has been prepared.

(2) TPS funding is planned, programmed, and budgeted according to existing policy.

(3) Type A, MIL–STD 490, TPS specifications are prepared.

(4) The acquisition strategy development and planning is drafted. This may result in a recommendation that the system-level category TPSs be acquired through the prime contractor. For all other TPSs an evaluation comparing acquisition from the prime contractor, independent TPS source, and an in-house development activity will be conducted and annotated in the TPSMP.

(5) Plans to acquire TPSs from an independent source will be supported by planning UUT availability, UUT documentation, testing specification, and configuration control methods.

b. Milestone II—Decision to enter FSED—

(1) The TPSMP has been updated and approved by the DEDT through the DEDT's designated agent, PM–TPS.

(2) The TPSs time-phasing is based on realistic projections of UUT design maturation. TPS charter will conform to the TPS engineering design standard as directed by procedures published by the DEDT.

(3) The testing specifications have been acquired or scheduled for each UUT according to the TPS time-phasing and the acquisition method as outlined in the TPS engineering design standard.

(4) The TPS requirements have been defined and updated by the RLA of the LSA.

(5) Sufficient Government engineering and product assurance personnel are dedicated to the defined verification, validation, and acceptance processes.

(6) Configuration management planning has been accomplished and includes schedules for transfer of configuration control for the UUTs and the TPSs to the Government. Early UUT design stabilization and configuration management must be consistent with the supported system operational readiness requirements.

(7) Failure detection and isolation requirements for the TPSs are specified in deterministic (coverage) and probabilistic (confidence) terms. Both specifications must be outlined in the TPSMP per approved Army TPS procedures/design standards.

c. Milestone III—Decision to enter production and deployment phase—

(1) The TPSMP has been updated and approved by the DEDT.

(2) As identified in the TPSMP, designated TPSs have successfully completed TT/UT test and evaluation.

(3) Funding and phasing of any additional TPSs are addressed.

(4) Interim contractor support and additional spares and other elements of support required prior to a full TPS deployment are included in the production contracts or other system support requirements established. Materiel fielding plans and agreements will address interim contractor support and TPS availability.

(5) Support facilities (to include all required ATE, UUTs, support environment, personnel, and funding) are planned and implemented per the procedures established by the PM–TPS.

(6) Methods for TPS identification, accountability, materiel release, maintenance, and deployment have been defined, developed, approved, and implemented in coordination with each gaining command organization under the direction of PM–TPS. USACTA will ensure that the resulting TPS database will be accessible to and compatible with TEMIS.

(7) Procedures for TPS modification, test, production, and deployment have been defined and approved in the materiel fielding plan (MFP) and TPSMP.

4–13. Designated TPS standard language

Test specification, test procedures, and TPSs for all Army ATE systems will use the DOD-approved American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 716/1987 C/ATLAS test language. Any new TPSs, test specifications, test procedural requirements not currently included in C/ATLAS may be the basis for an ATE policy waiver within the following constraints:

a. The identification of a requirement for non-C/ATLAS modules, procedures, or language extensions will not be used as a basis for a waiver of specifications currently covered by C/ATLAS constructs.

b. Each request for policy deviation must include the technical basis for each non-C/ATLAS capability in sufficient detail to permit preparation of a C/ATLAS change proposal to the DOD ATE language standardization committee (DALSCOM) for sponsorship to IEEE. The proposal must include plans for implementing the change proposal on an Army C/ATLAS compiler.

c. Software necessary to process non-C/ATLAS requirements (e.g., assemblers, compilers, translators, loaders, post processors, and utility programs) will be procured with sufficient rights in data to permit software support by the U.S. Government without recourse to any contractor assistance.

d. TPS language waivers will be processed according to paragraph 4–5.

Section IV
Acquisition of TPS

4–14. General

TPS acquisition will be planned as a separate (program controlled) item consistent with the importance of the TPS and the end system it supports. The central document for planning, developing, acquiring, and maintaining the TPS is the TPSMP.

4–15. TSPMP

a. Intent. The intent of the TPSMP will be to establish uniformity and visibility of TPS acquisition and obtain TPS to support the users needs at the lowest weapon system life cycle cost. The TPSMP will be written to reflect the requirements of the weapon system life cycle.

b. Content.

(1) The approved TPSMP is required prior to the prime weapon system entering FSED.

(2) In section III of the TPSMP, *Acquisition Management*, the TPS materiel manager (program manager or developing laboratory project leader), will clearly address the alternatives of acquiring TPS via—

(a) In-house (organic) development, showing the cost/schedule proposal according to the standard TPS WBS.

(b) Prime weapon system contractor development.

1. Phase 1—Preliminary design review (PDR). A TPS PDR will be conducted to determine if TPS philosophy is in concert with existing DEDT approved UUT source technical data. TPS elements will be standardized.

2. Phase 2—Critical design review (CDR). A TPS CDR will be conducted and will serve to resolve all open issues prior to TPS hardware/software integration.

3. Phase 3—Prototype test program (TP). Test accessories, and draft operator TM test program instruction inserts are developed. This includes successful government validation and verification testing of TPSs.

4. Phase 4—Production TP. Test accessories and final draft TPS TMs (TPSs and test accessory TMs) are developed.

(3) An exception to competitive acquisition of TPS may be made for acquisition of system-level TPSs.

(a) Relatively few TPSs are required at the system-level of design for demonstration during technical test and internal operational test and evaluation in the prime weapon system FSD phase.

(b) The prime weapons system contractor would be the best source for these initial, early-on system-level TPS. The TPSMP will prioritize the development of TPSs by UUT failure rate and life-cycle cost savings.

c. TPSMP preparation and approval.

(1) The TPS materiel manager (i.e., program manager, development laboratory project leader, MDC, or their major subordinate command (MSC)) is responsible for assuring the development of the TPSMP.

(a) The TPS Center of the supporting command will act as the principal staff adviser to the TPS materiel manager for the TPSMP. The task of preparing the TPSMP may be assigned to the TPS Center, which will further task the principal matrix support elements for appropriate assistance.

(b) The TPS Center will coordinate the development of the TPSMP and will ensure final integration of all sections of the plan.

(2) The TPSMP will be provided for approval to the Program Manager, Test, Measurement and Diagnostic Equipment, Attn: AMCPM-TMDE-ASI, Fort Monmouth, NJ 07703–5209. A copy of the TPSMP will be sent to the Commander, U.S. Army Central TMDE Activity, Attn: AMXCT, Lexington, KY 40511–5104.

(3) The TPS Center will have staff responsibility for concurrence/nonconcurrence of the TPSMP. AMC (AMCPM-TMDE-ASI) will consider all comments of the TPS centers prior to approving/disapproving the TPSMP. AMC (AMCPM-TMDE-ASI) disapproval of the TPSMP will be coordinated through the DEDT.

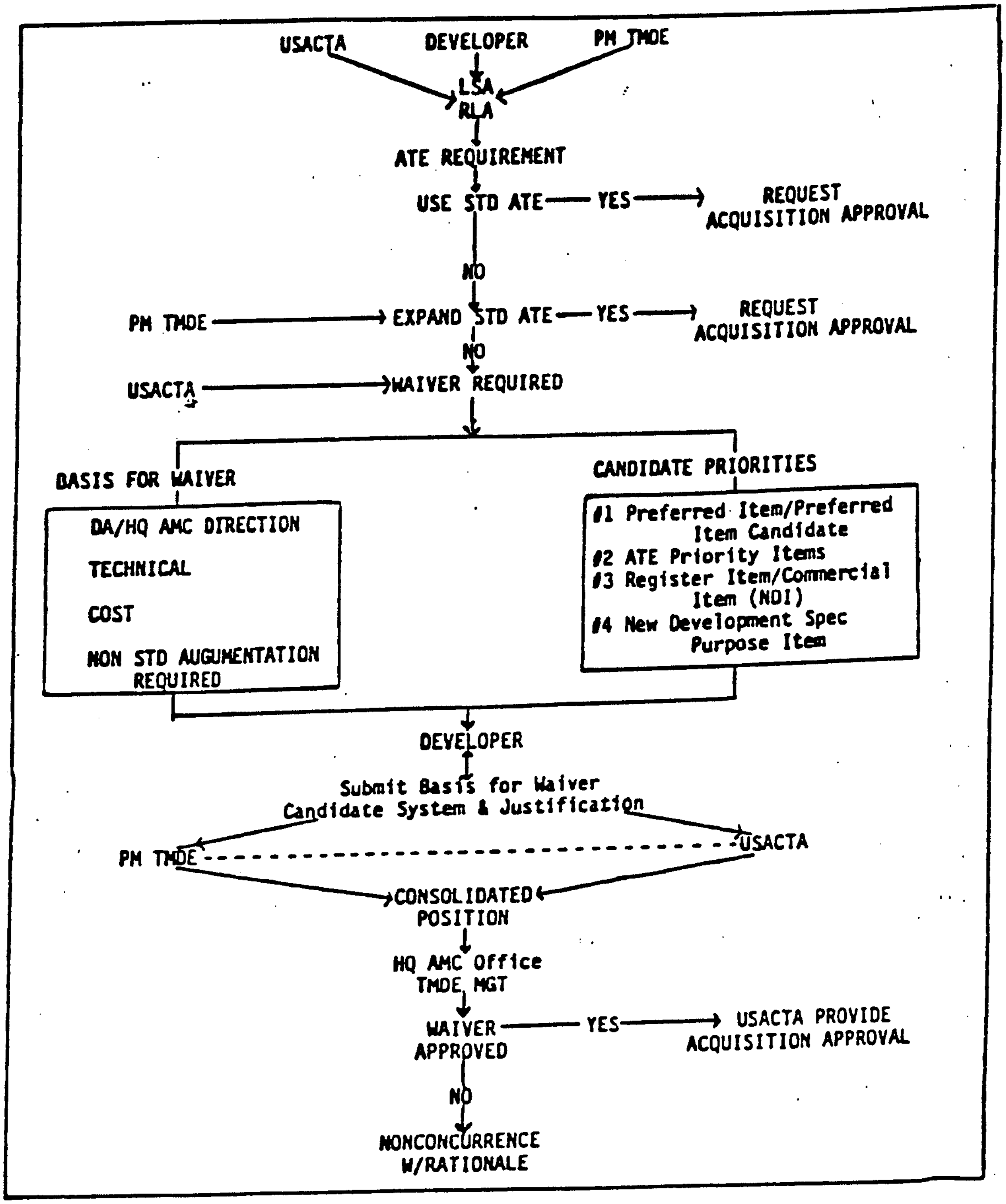


Figure 4–1. ATE selection process

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